Pathology LAB 1
(Cell Injury)

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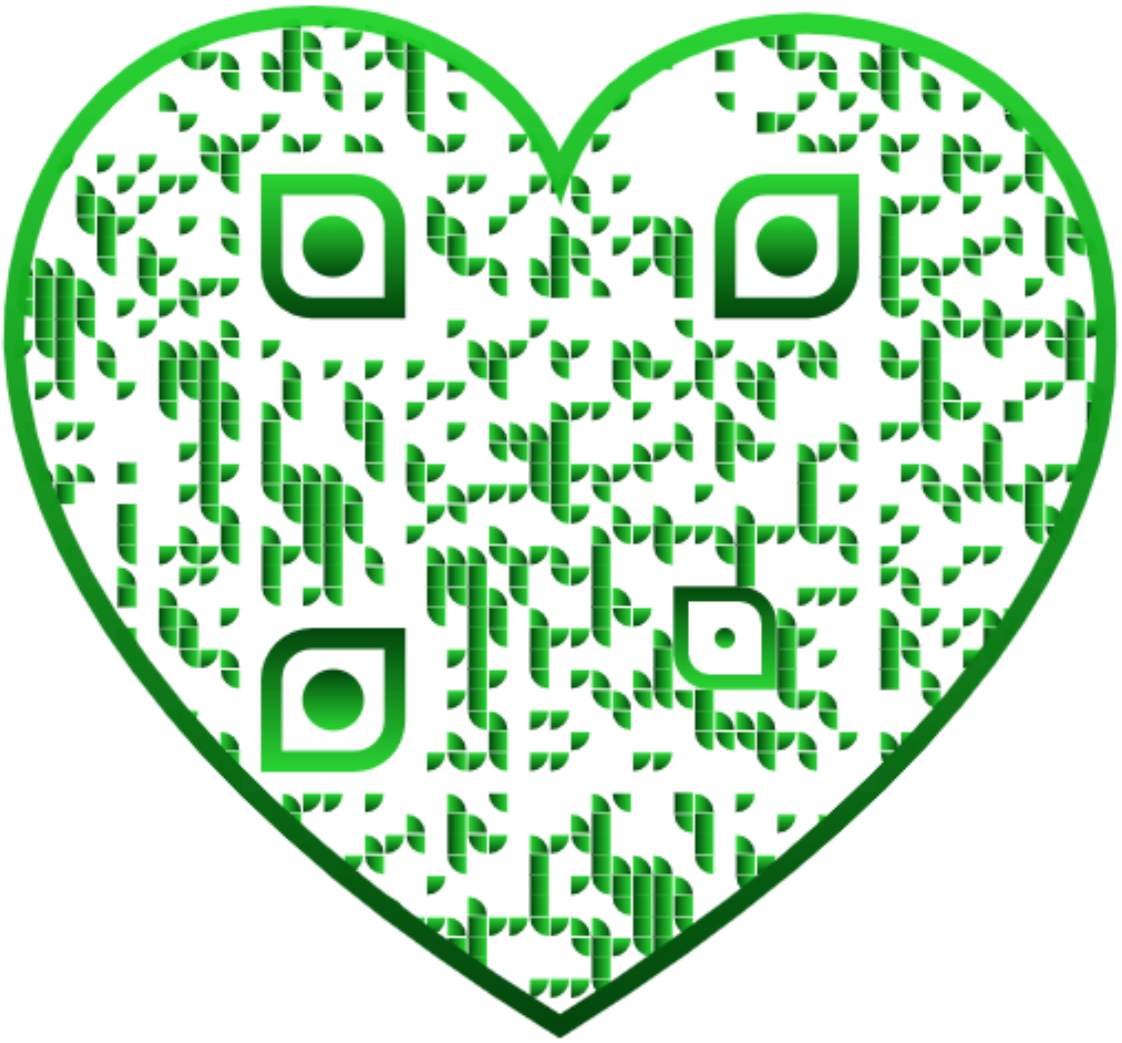
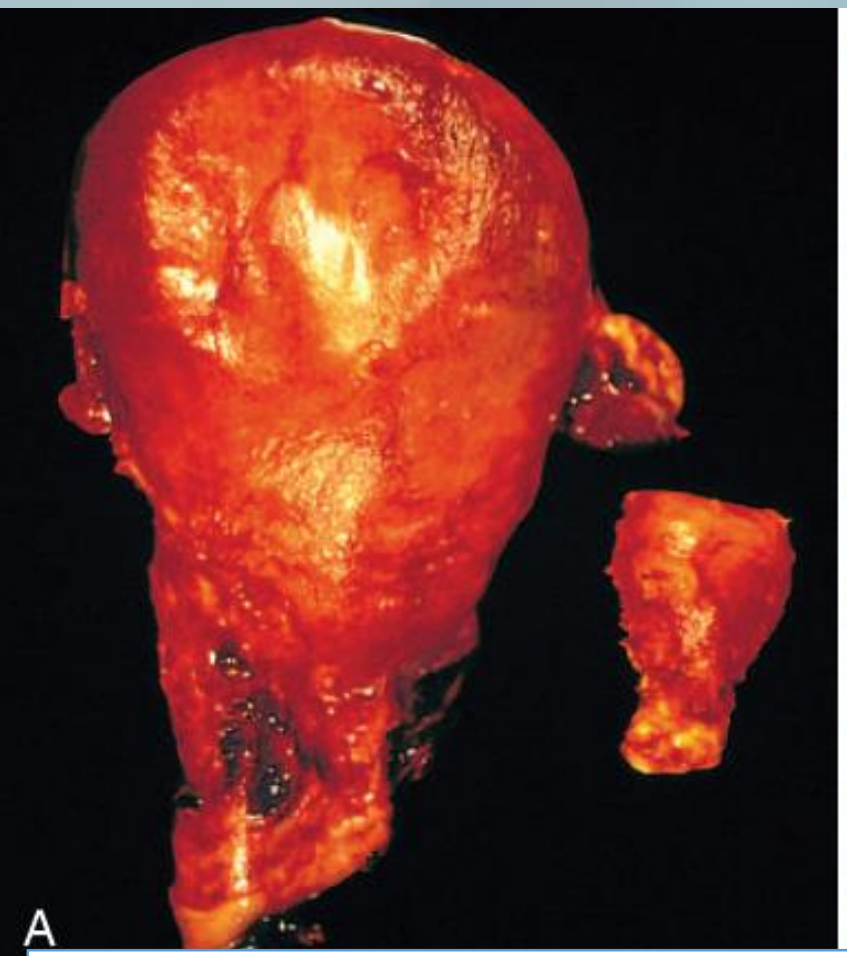
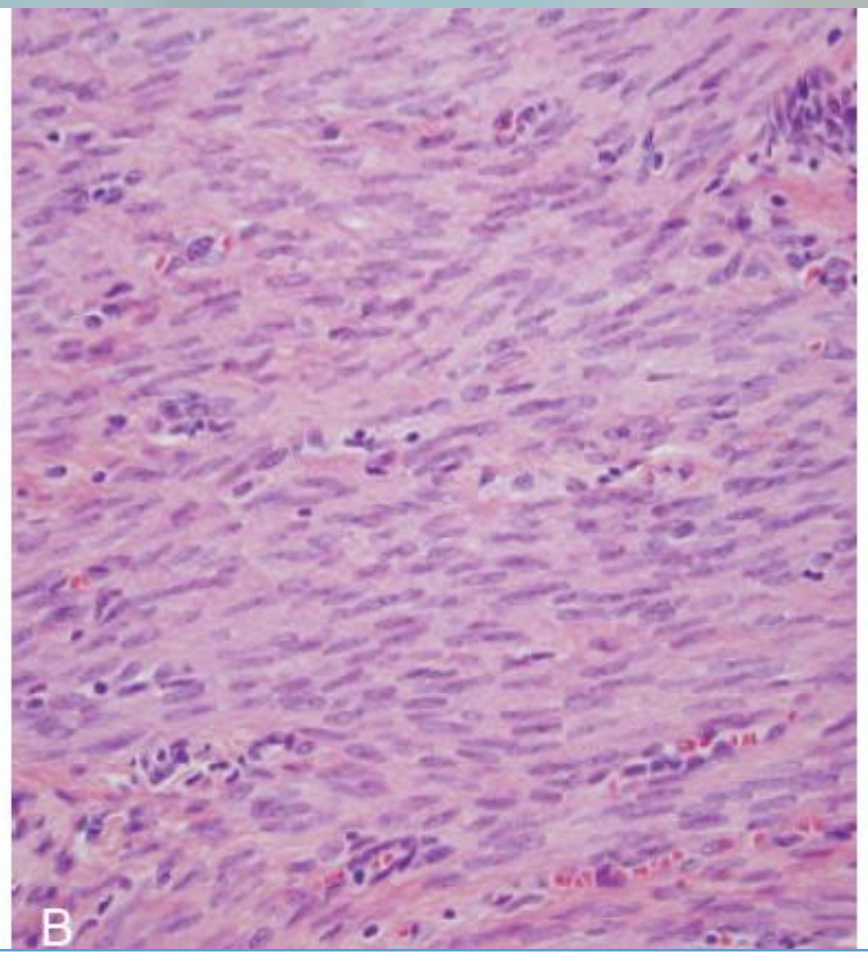


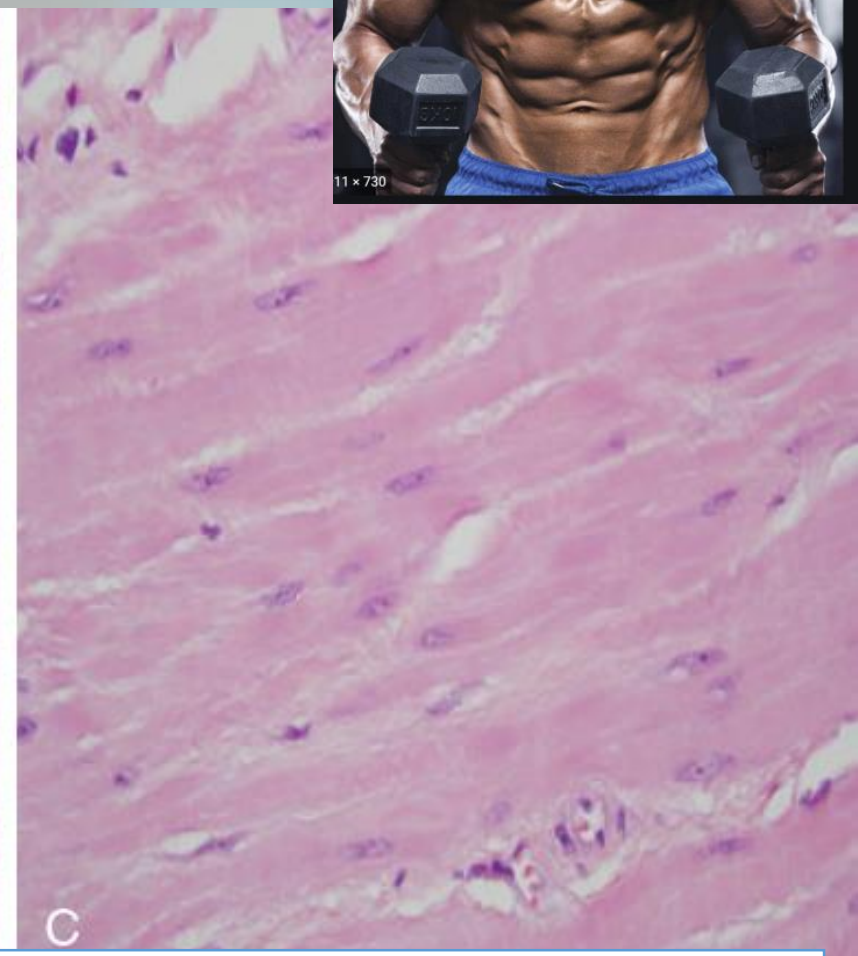
CELLULAR ADAPTATIONS TO STRESS

- **Hypertrophy:** increased cell and organ size, often in response to increased workload; induced by growth factors produced in response to mechanical stress or other stimuli; occurs in tissues incapable of cell division.
- **Hyperplasia:** increased cell numbers in response to hormones and other growth factors; occurs in tissues whose cells are able to divide or contain abundant tissue stem cells.
- **Atrophy:** decreased cell and organ size, as a result of decreased nutrient supply or disuse; associated with decreased synthesis of cellular building blocks and increased breakdown of cellular organelles and autophagy.
- **Metaplasia:** change in phenotype of differentiated cells, often in response to chronic irritation, that makes cells better able to withstand the stress; usually induced by altered differentiation pathway of tissue stem cells; may result in reduced functions or increased propensity for malignant transformation.

Hypertrophy: Physiologic







Physiologic hypertrophy of the uterus during pregnancy. (A) Gross appearance of a normal uterus *(right)* and a gravid uterus *(left)* that was removed for postpartum bleeding. (B) Small spindle-shaped uterine smooth muscle cells from a normal uterus. (C) Large, plump hypertrophied smooth muscle cells from a gravid uterus; compare with B. (*B* and *C,* Same magnification)

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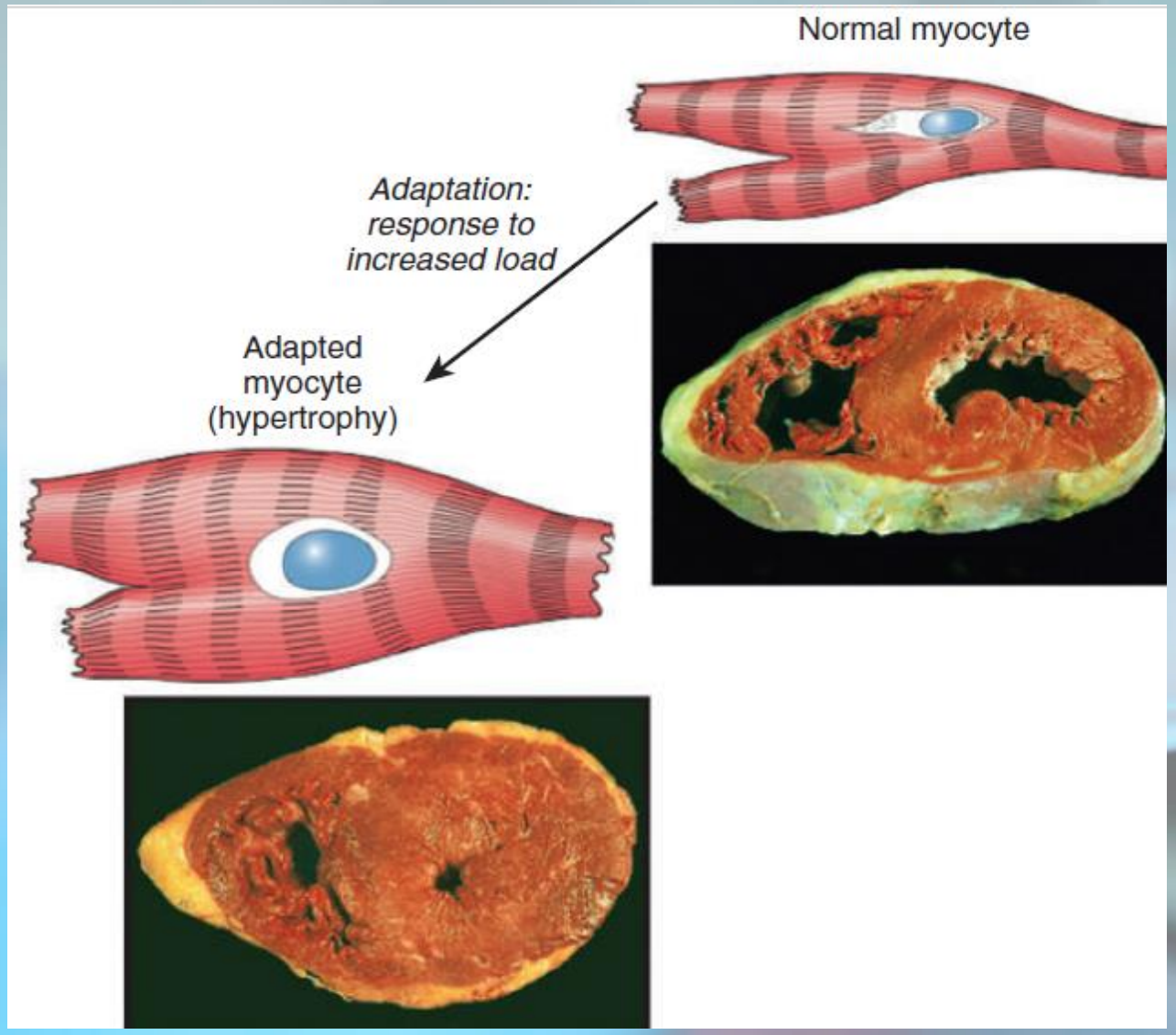
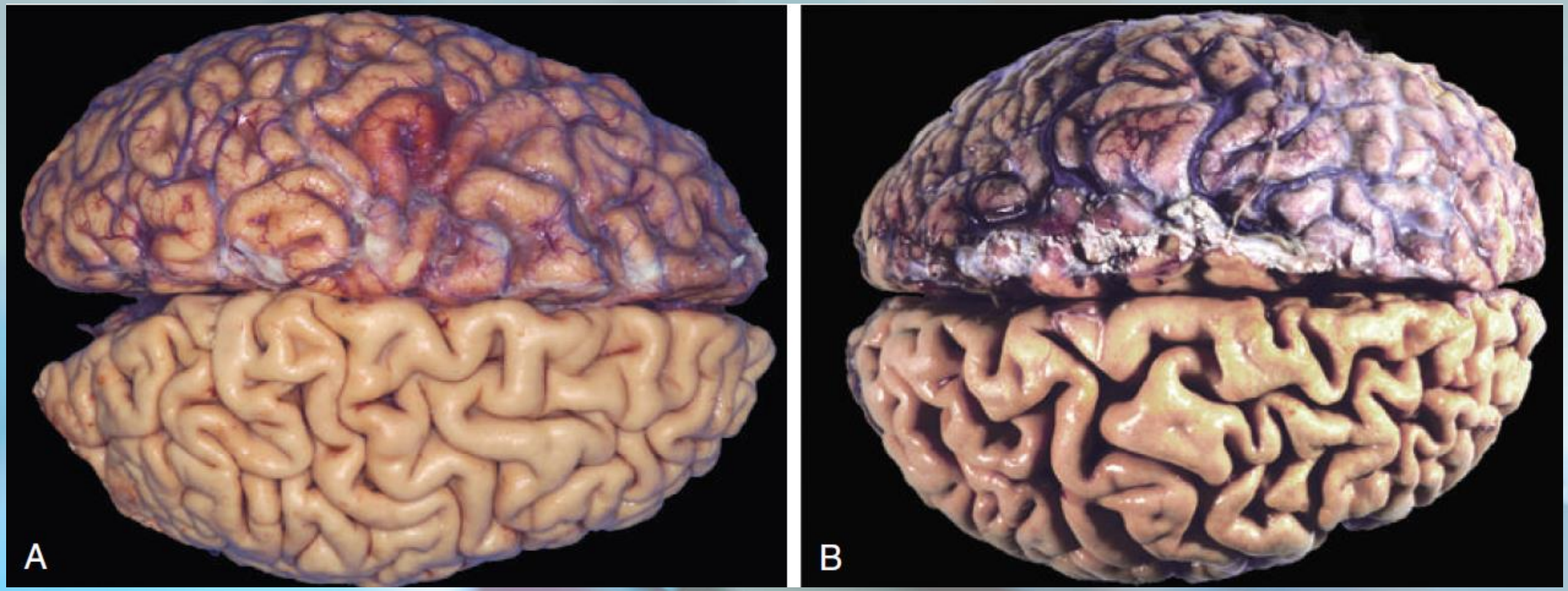
Hypertrophy: Pathologic



Atrophy: Gross



(A) Normal brain of a young adult.
(B) Atrophy of the brain: loss of brain substance, narrowing of gyri and widening of sulci.

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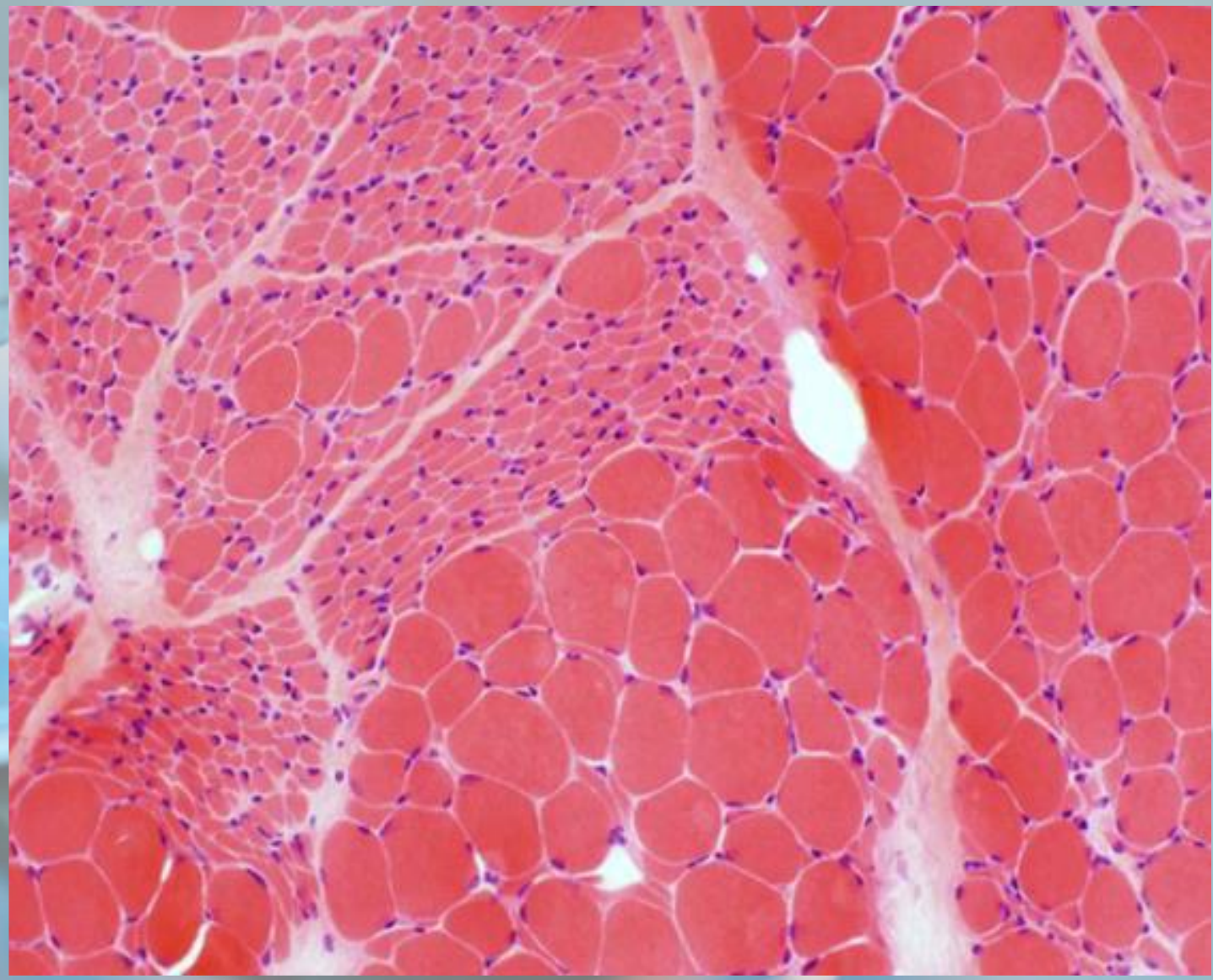
Atrophy: Microscopic

Some of skeletal muscle fibers here show **atrophy**, compared to normal fibers. The number of cells is the same as before the atrophy occurred, but the size of some fibers is reduced.

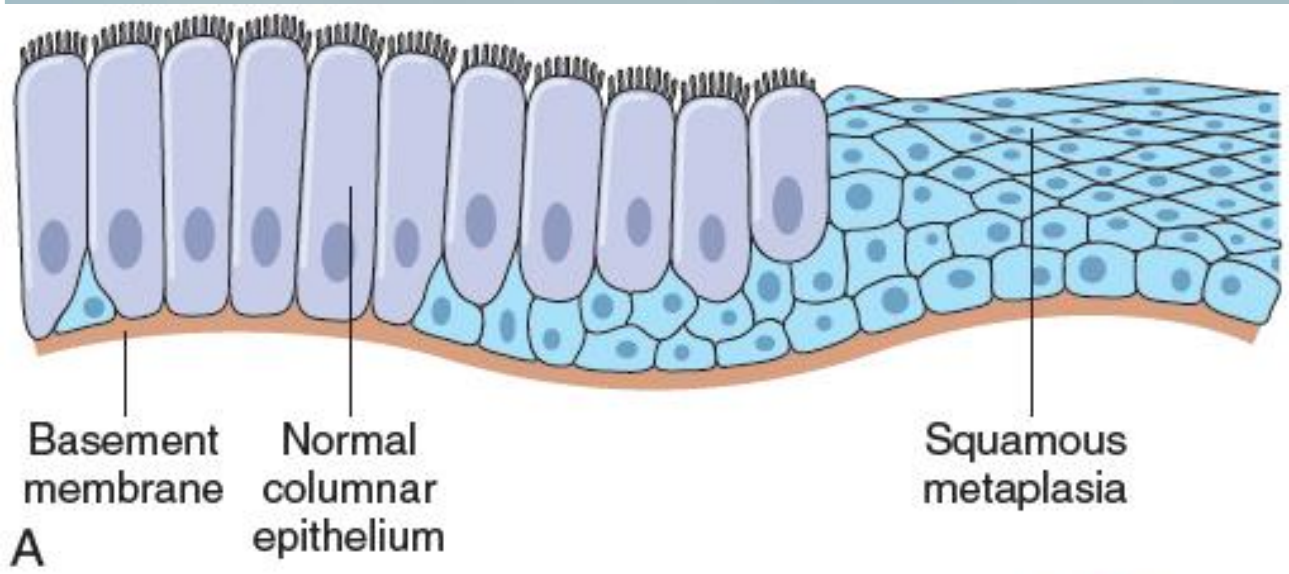


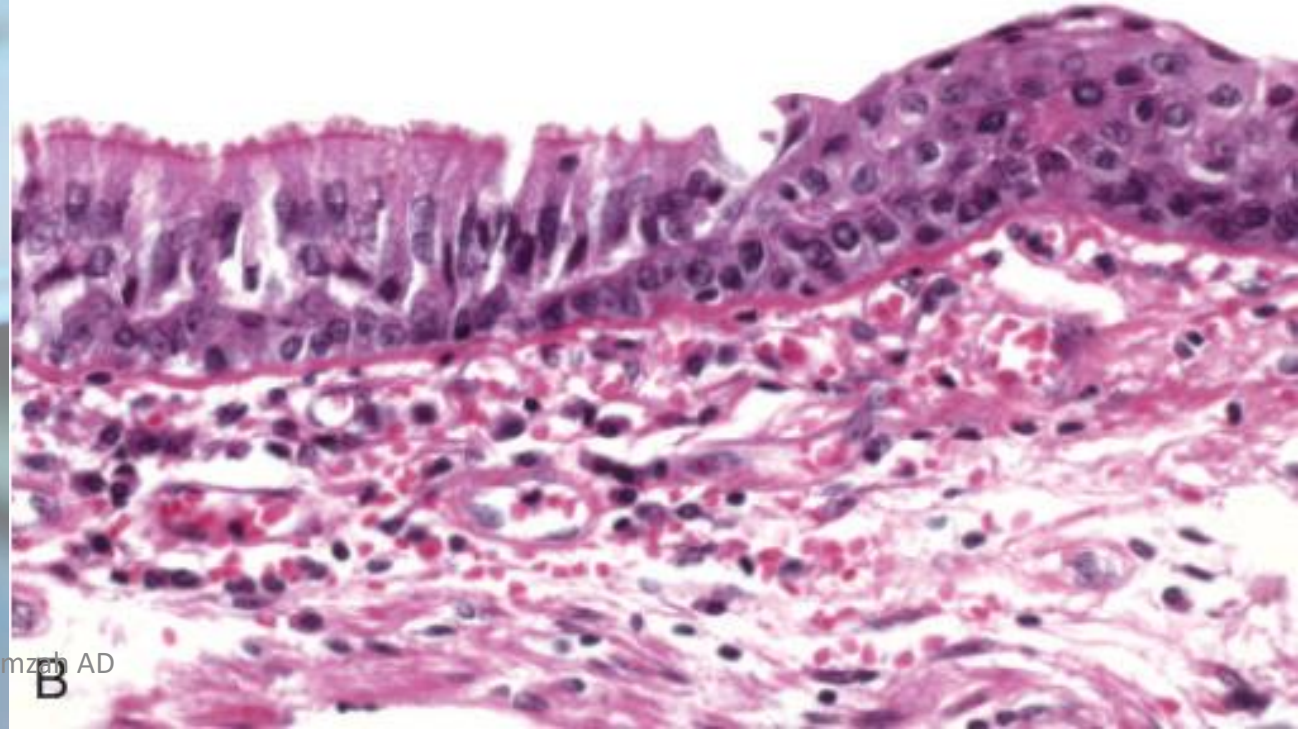
Metaplasia:

Gross: Endoscopic image of Barrett's esophagus shows change in color of esophagus due to prolonged exposure to gastric acid

Metaplasia: Microscopic

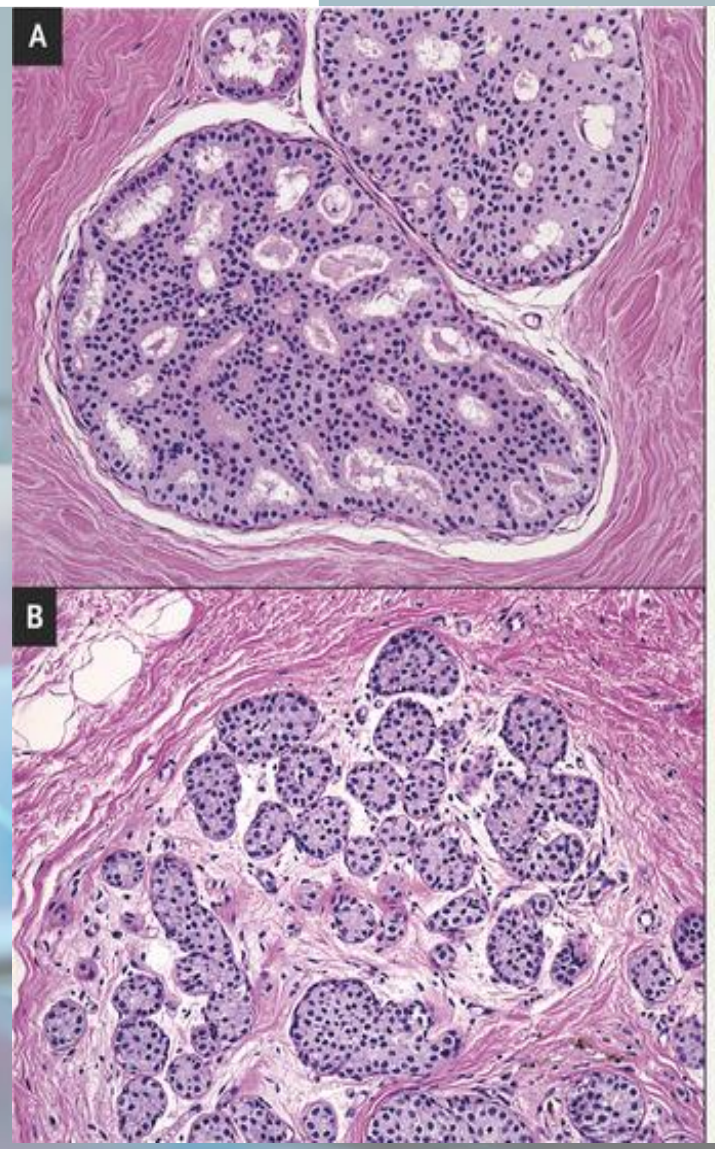
Metaplasia of normal columnar *(left)* to squamous epithelium *(right)* in a bronchus, shown schematically (A) and histologically (B).

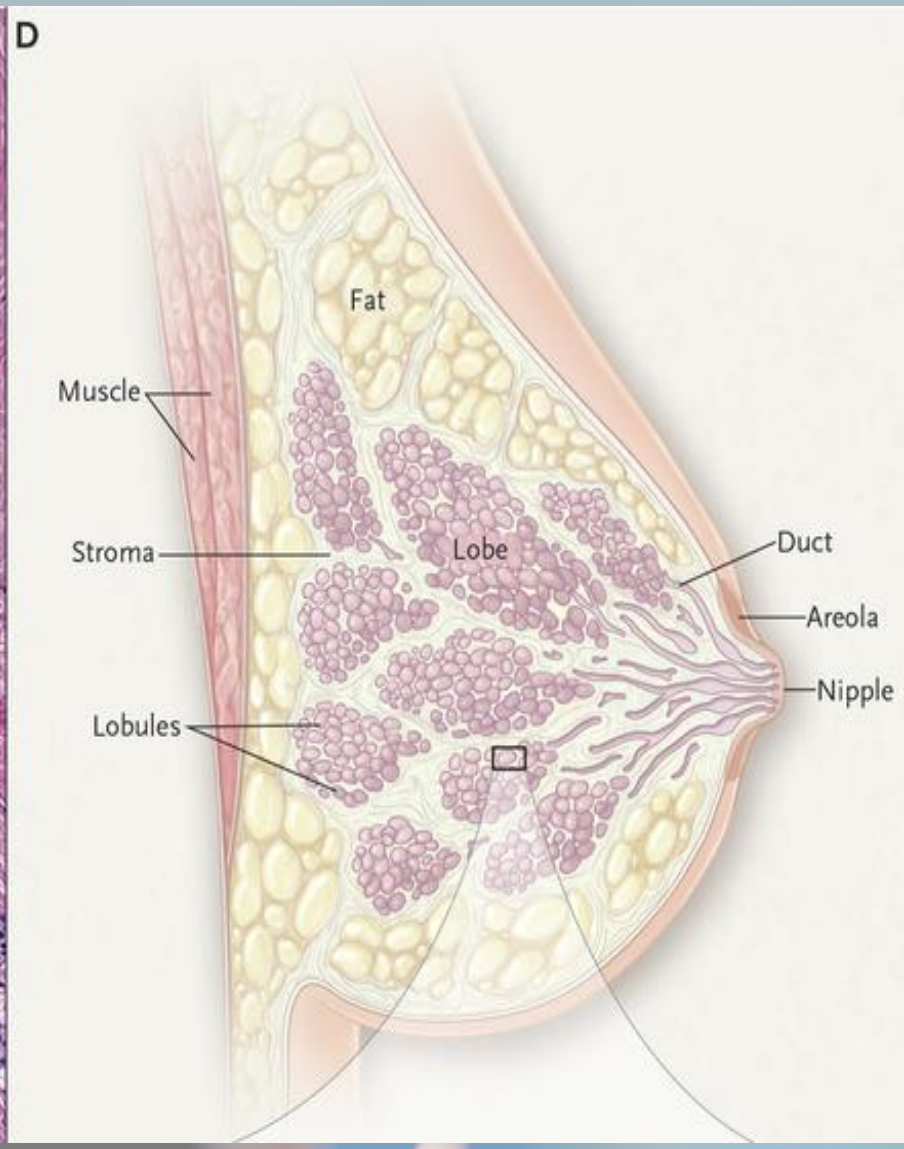




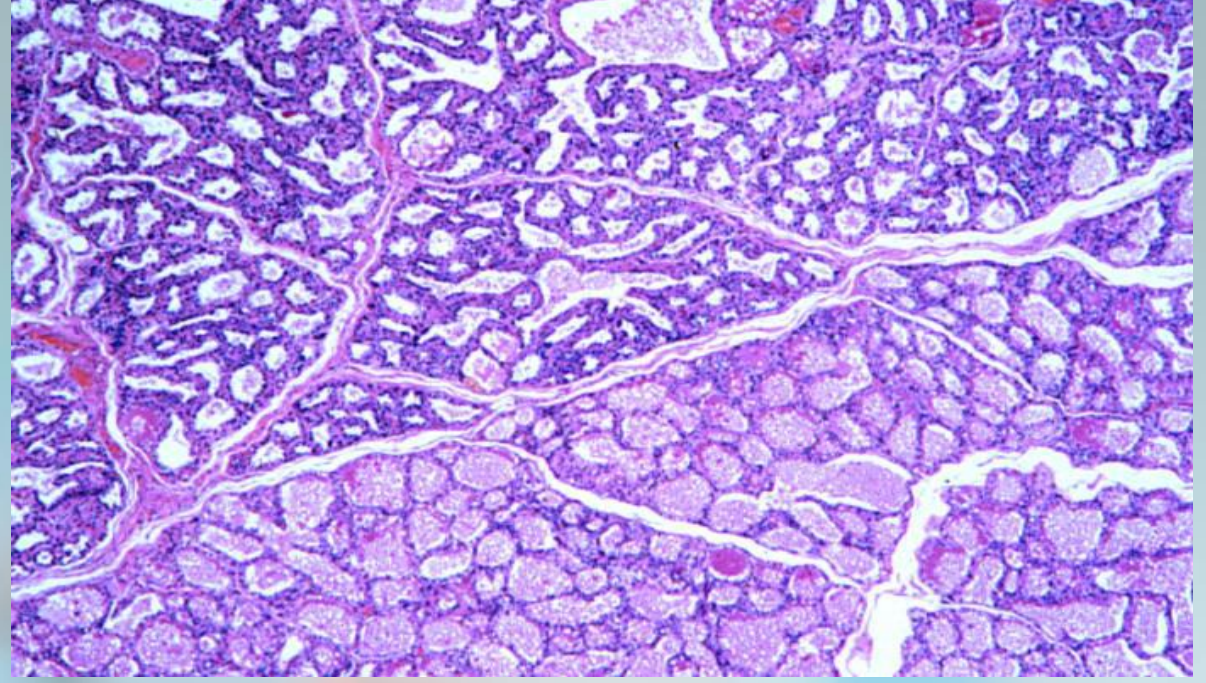
Hyperplasia

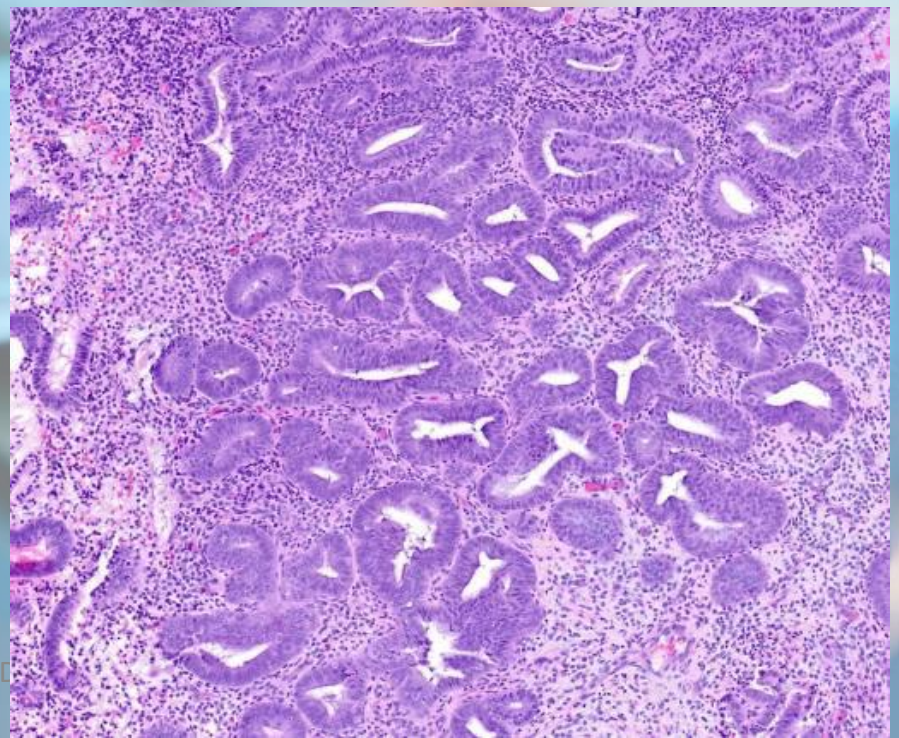
increased breast gland numbers in response to hormones during pregnancy and lactation.
Note here increased gland/stromal ratio

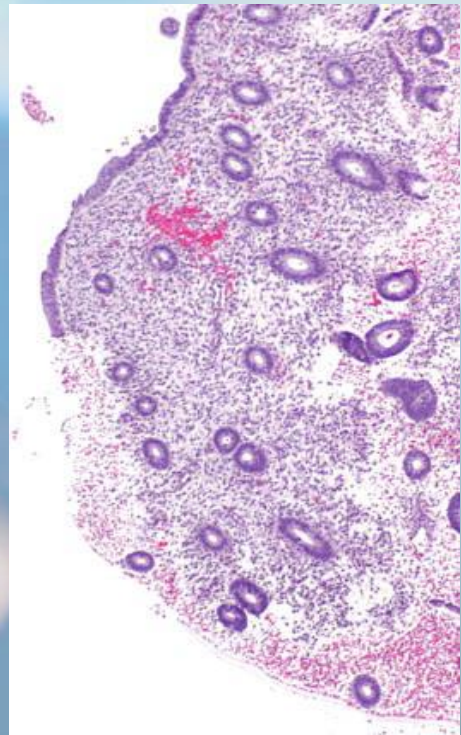




Hyperplasia





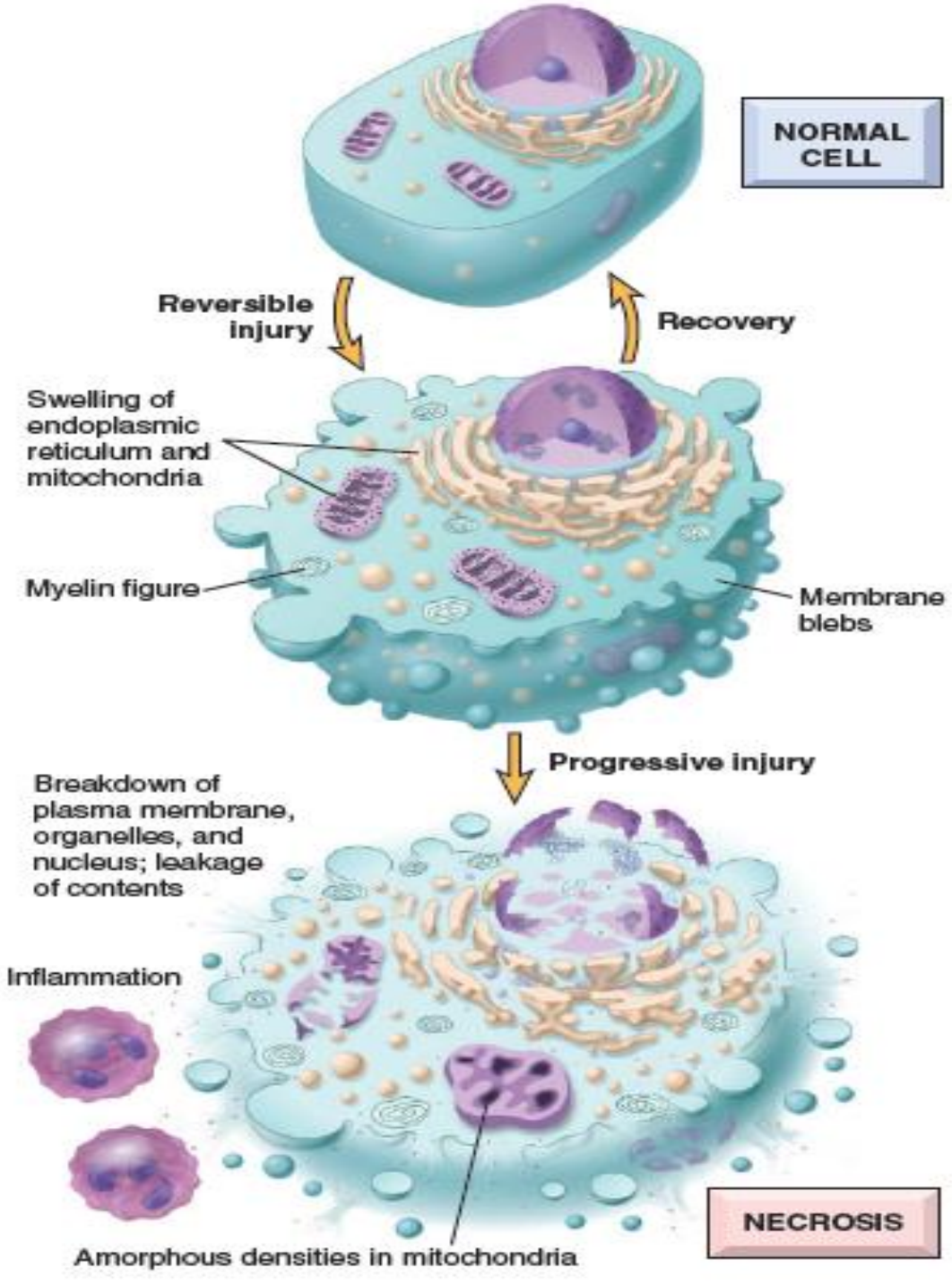


Cell Injury

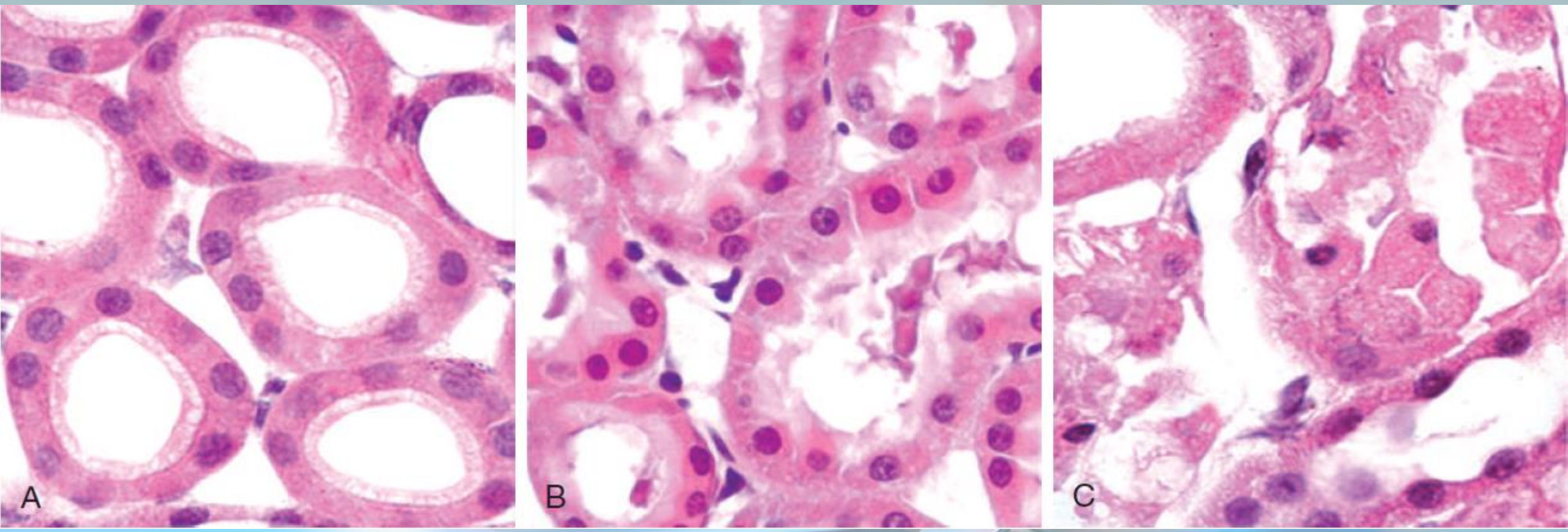
Reversible Cell Injury

Reversible injury is the stage of cell injury at which the deranged function and morphology of the injured cells can return to normal if the damaging stimulus is removed.

The two main morphologic correlates of reversible cell injury are cellular swelling and fatty change.

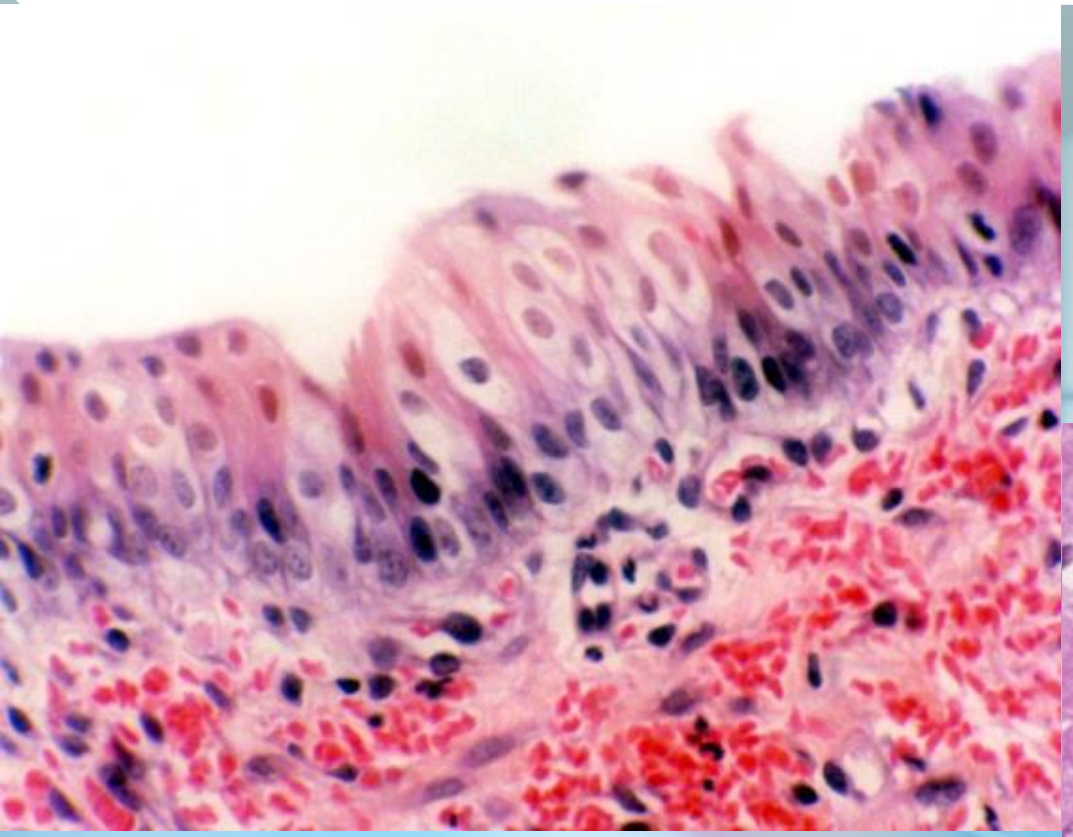


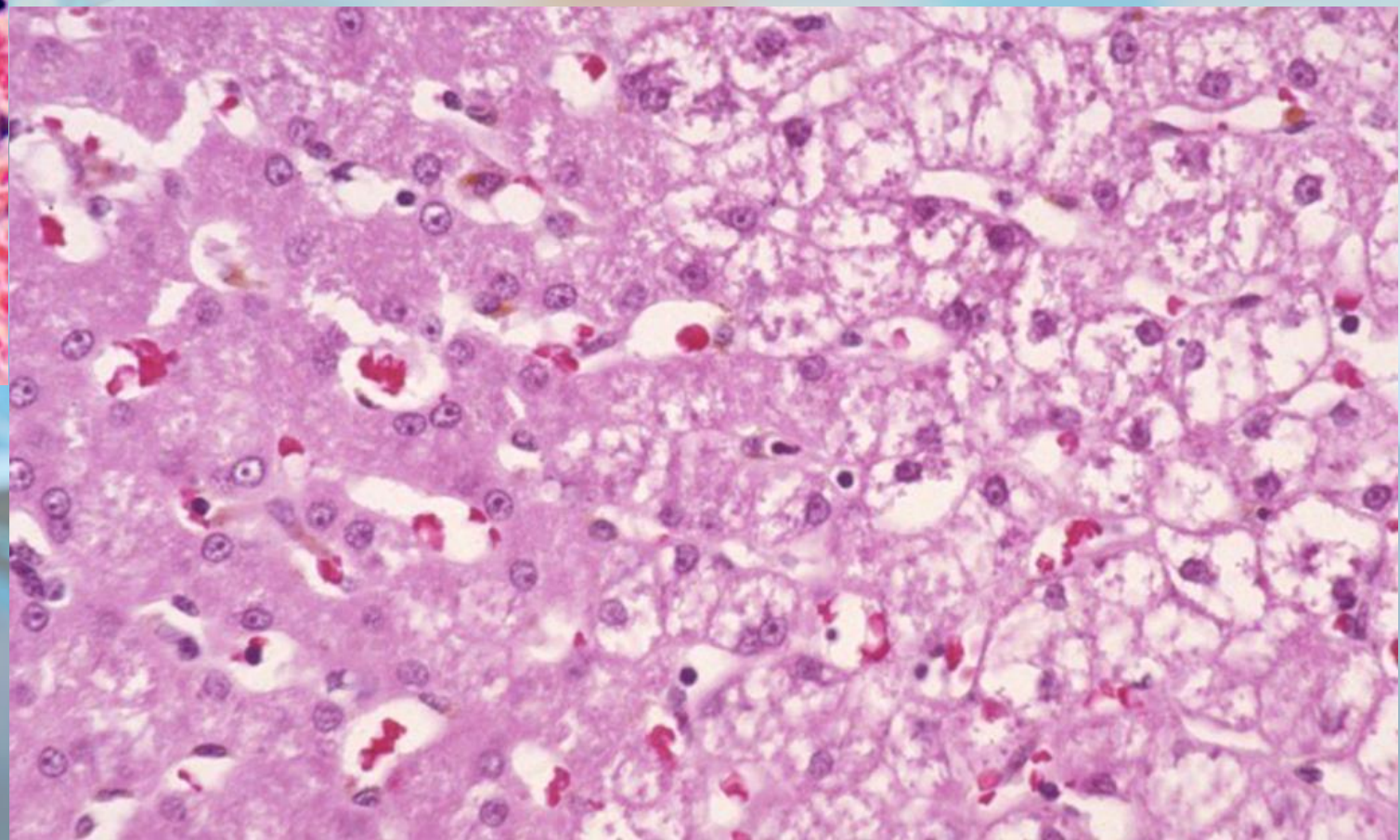
Cell Injury



(A) Normal kidney tubules with viable epithelial cells.
(B) Early (reversible) ischemic injury showing surface blebs, increased eosinophilia of cytoplasm, and swelling of cells.
(C) Necrotic (irreversible) injury of epithelial cells, with loss of nuclei and fragmentation of cells and leakage of contents.

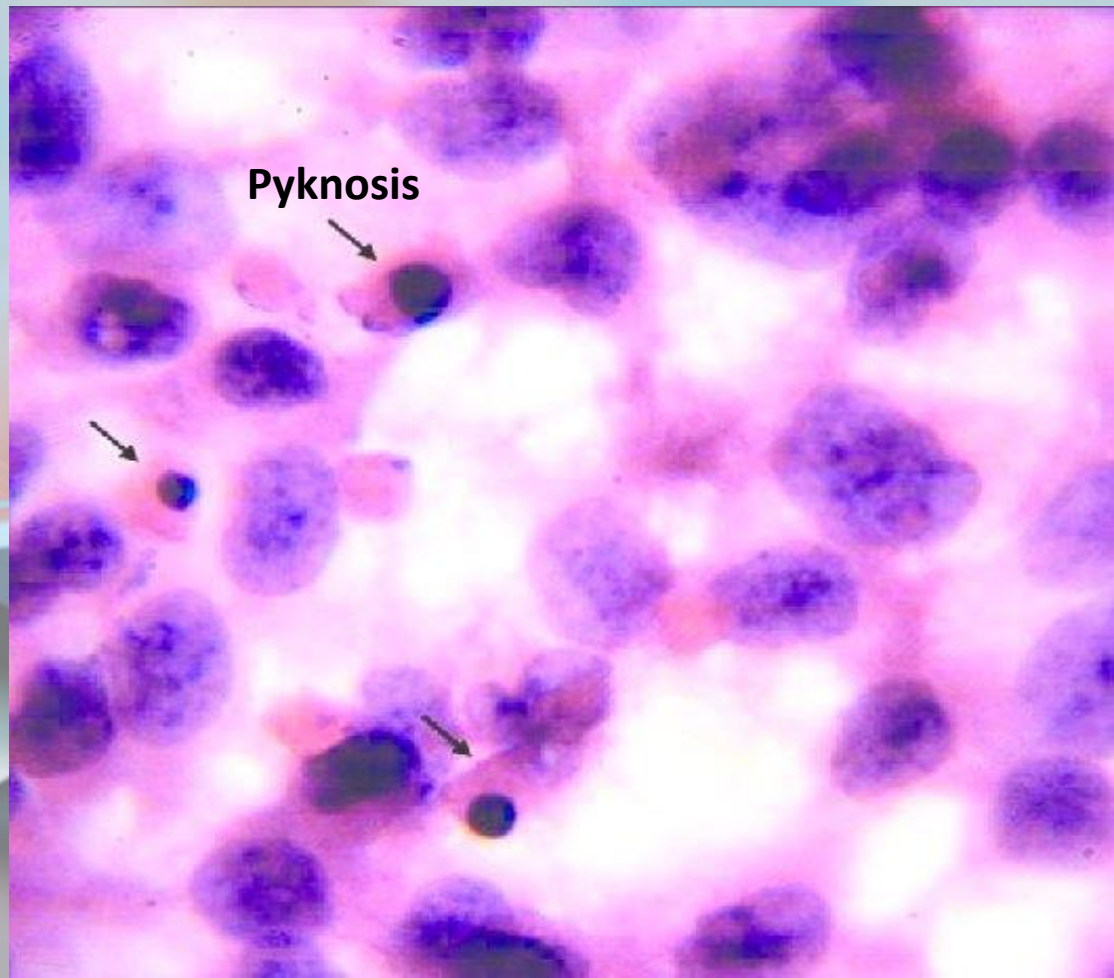
Cell swelling: reversible





Nuclear changes in necrosis: Nuclear changes result from a breakdown of DNA and chromatin:

1. **Pyknosis:** nuclear shrinkage and increased basophilia; the DNA condenses into a dark shrunken mass.
2. **Karyorhexis:** The pyknotic nucleus undergo fragmentation
3. **Karyolysis**: the basophilia fades because of digestion of DNA by deoxyribonuclease (DNase) activity.



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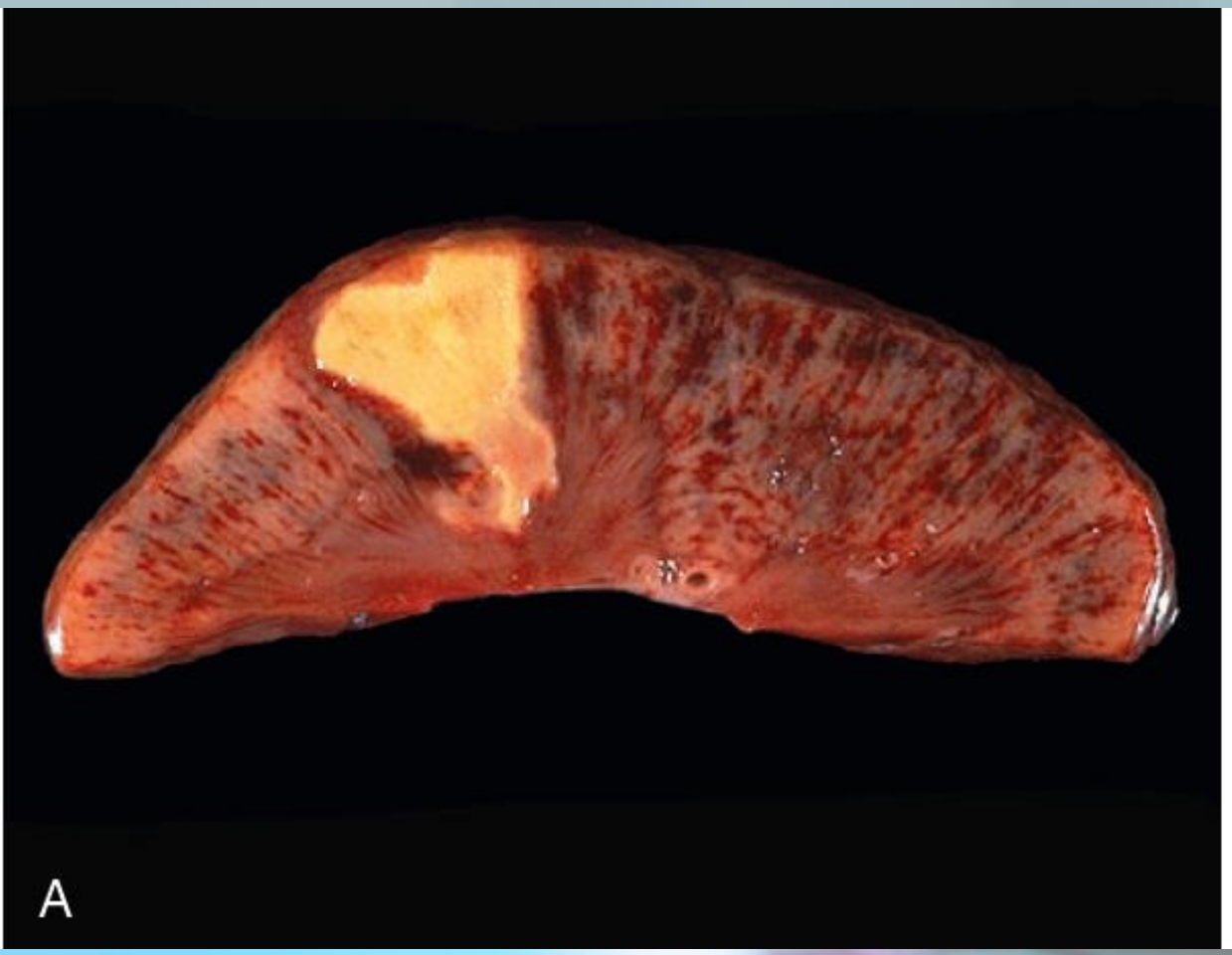
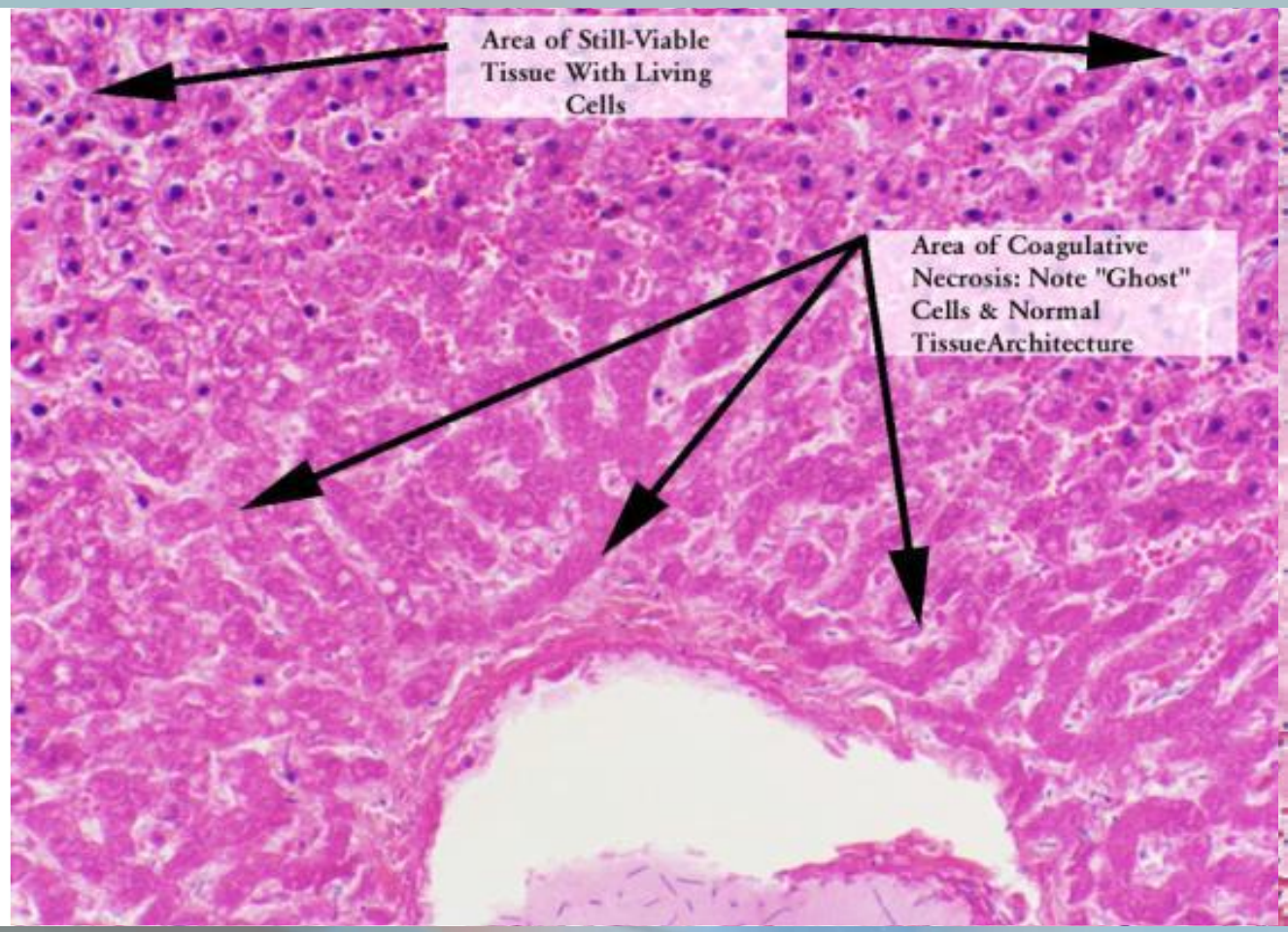
Types of Necrosis: 1. Coagulative Necrosis

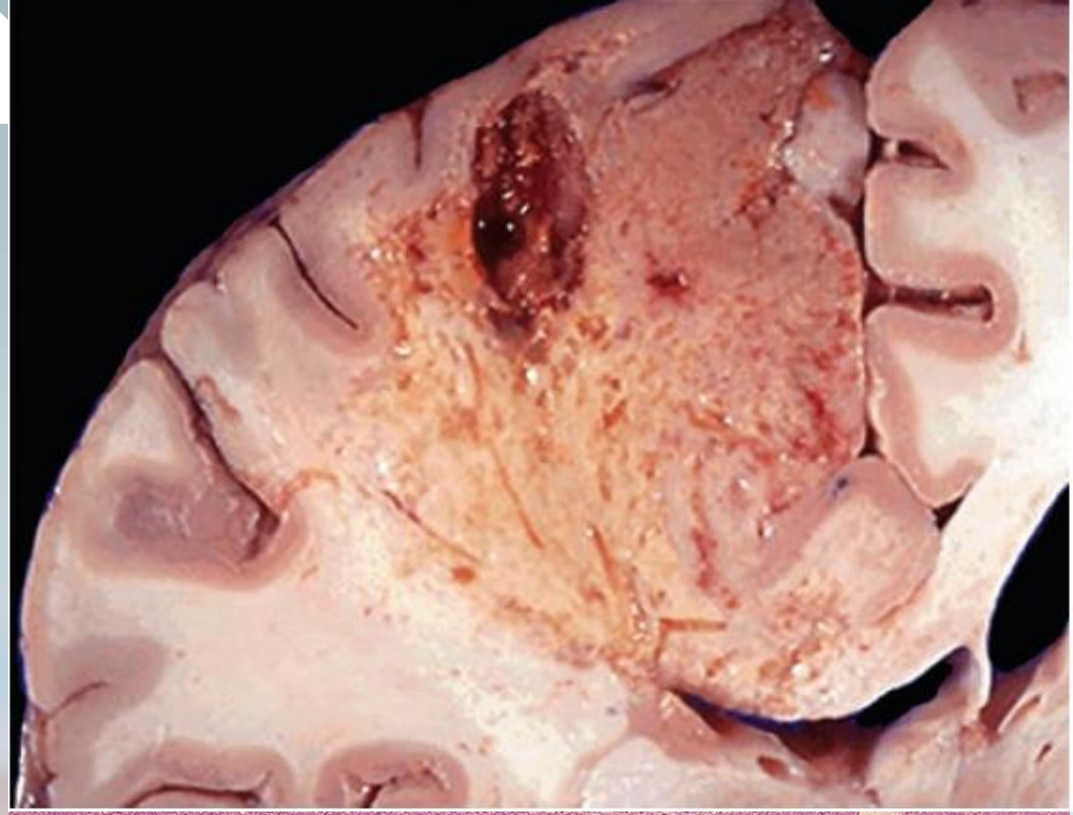



Area of Still-Viable Tissue With Living Cells
Area of Coagulative Necrosis: Note "Ghost" Cells & Normal TissueArchitecture

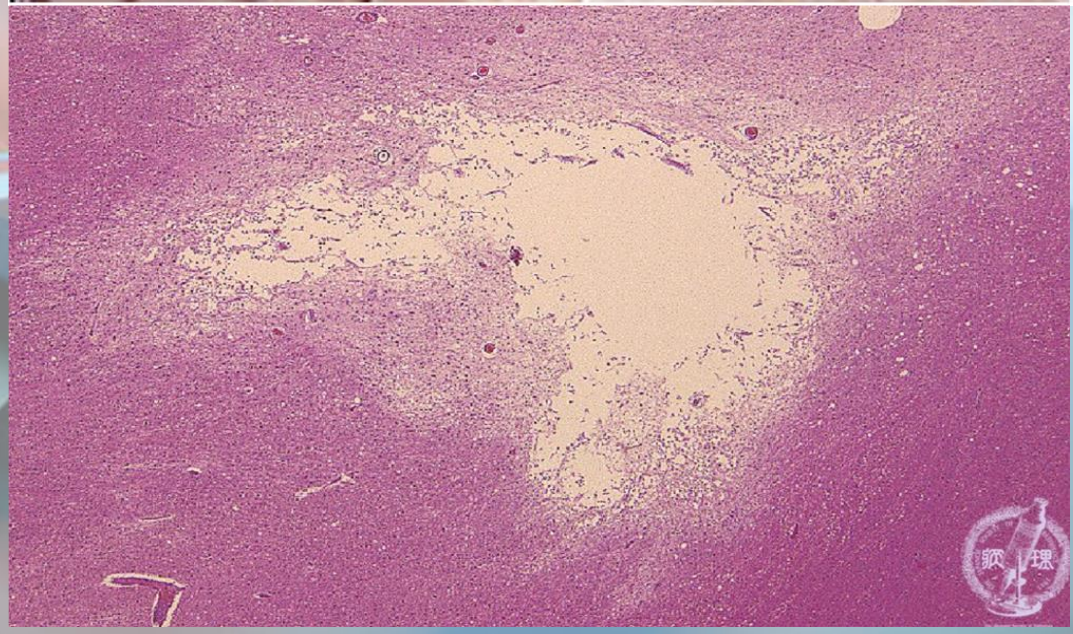
(A) A wedge-shaped kidney infarct *(yellow)* with preservation of the outlines.
(B) Microscopic view of the edge of the infarct, with normal kidney *(N)* and necrotic cells in the infarct *(I)*. The necrotic cells show preserved outlines (ghost cells) with loss of nuclei, and an inflammatory infiltrate is present (difficult to discern at this magnification).

Types of Necrosis: 2. Liquefactive Necrosis

Gross: Liquefactive necrosis of Brain.
An infarct in the brain shows dissolution of the tissue. There is a liquid center in an area of tissue injury.



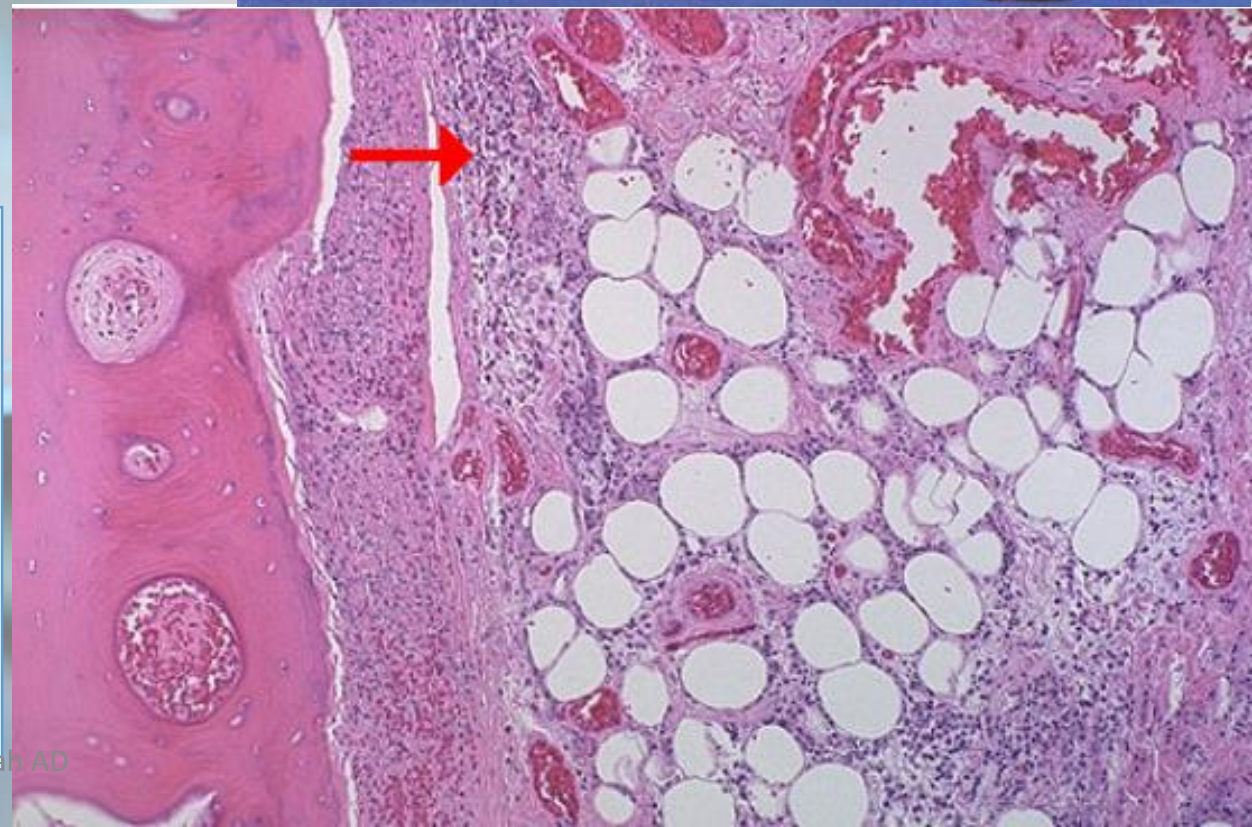
Microscopic: low-power photomicrograph containing a large abscess. The center of the abscess contains necrotic debris and there is a rim of viable inflammatory cells surrounding this abscess.



Types of Necrosis: 3. Gangrenous Necrosis

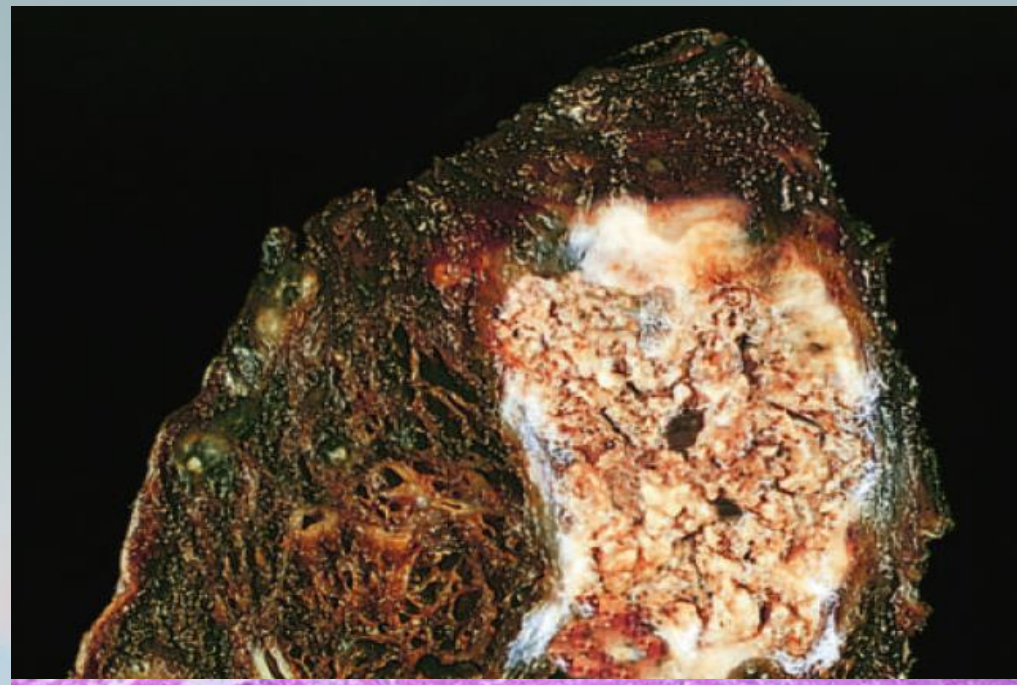
Gross: This is gangrene of the lower extremity. necrosis from loss of blood supply.
This patient had diabetes mellitus with severe peripheral vascular disease.

Microscopic: Gangrenous necrosis involves the tissues of a body part. The **inflammation** seen here is extending beneath the skin of a toe to involve soft tissue (fat and connective tissue at the right) and bone (at the left). Because multiple tissues are non-viable, amputation of such areas is necessary.

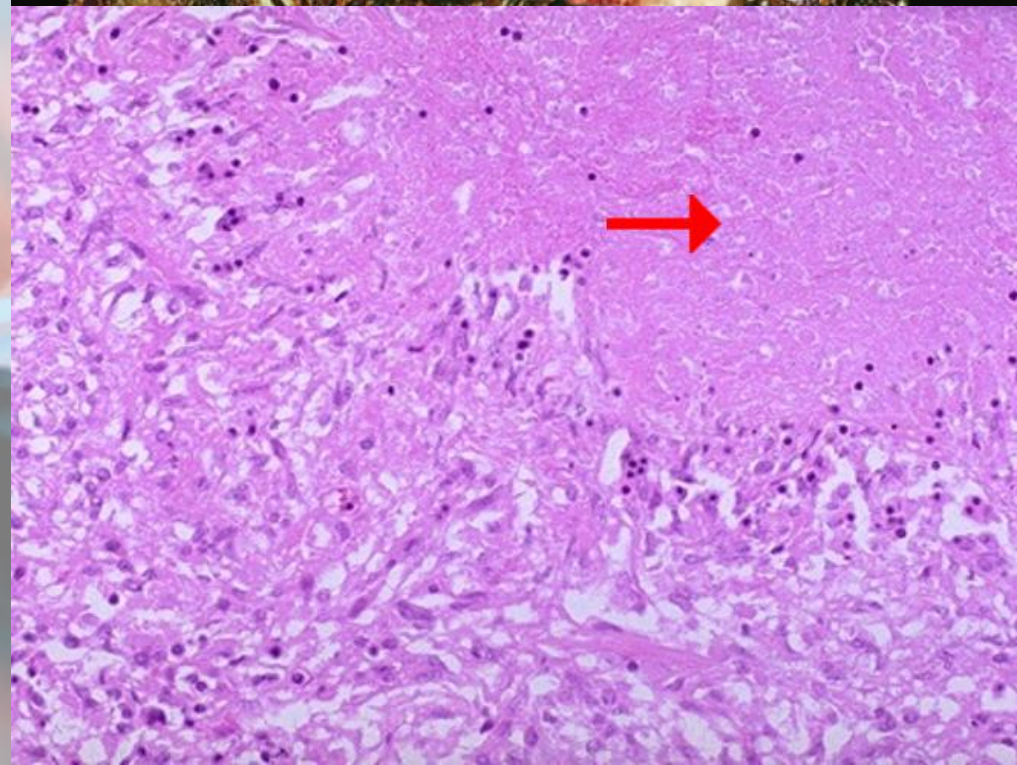


Types of Necrosis: 4. Caseous Necrosis

Gross: Caseous necrosis. Tuberculosis of the lung, with a large area of caseous necrosis containing yellow-white (cheesy) debris.

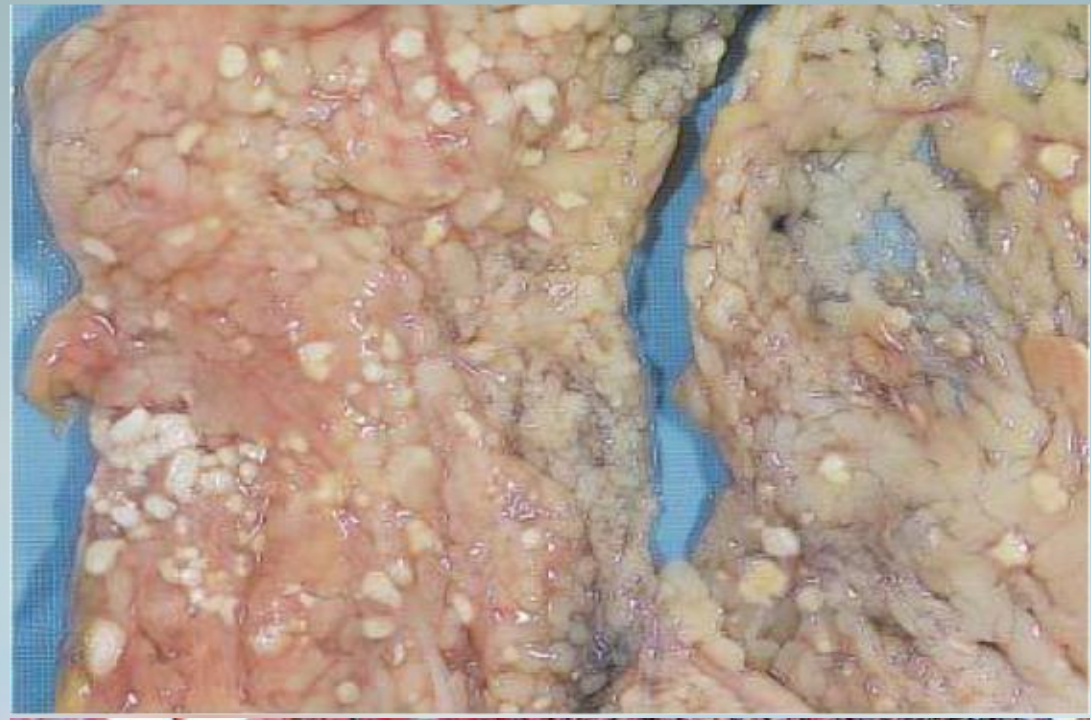


Microscopic: caseous necrosis characterized by **acellular pink areas** of necrosis, as seen here at the upper right, surrounded by a granulomatous inflammatory process.

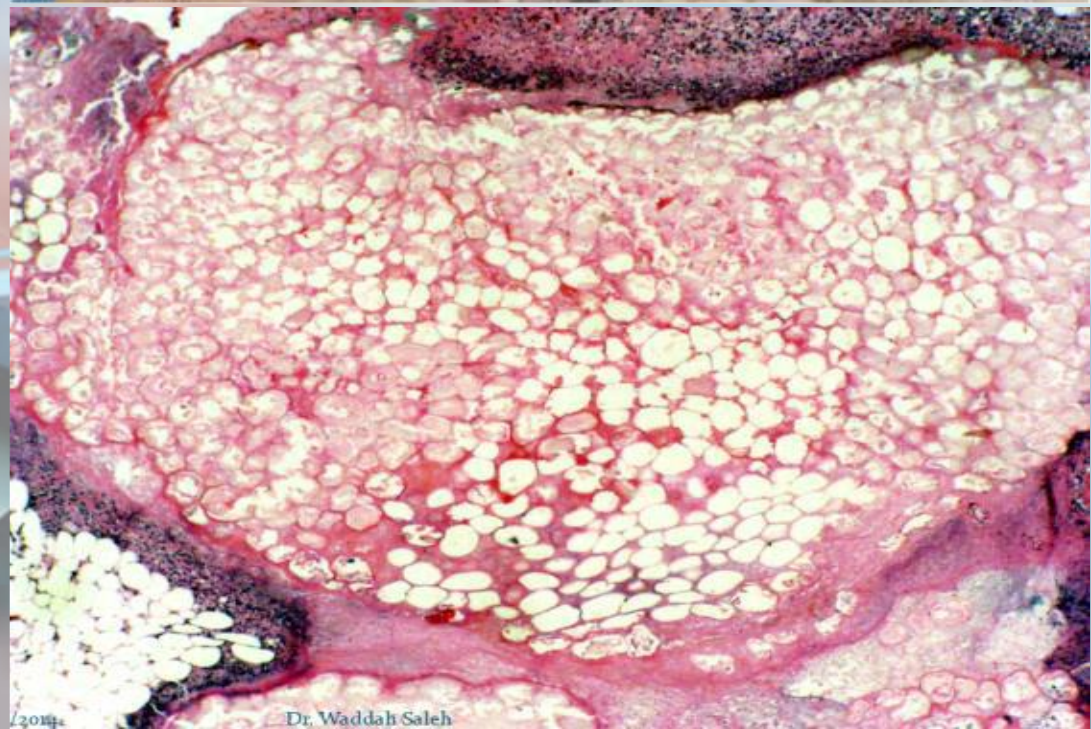


Types of Necrosis: 5. Fat Necrosis

Gross: Fat necrosis in acute pancreatitis. The areas of white chalky deposits represent foci of fat necrosis with calcium soap formation (saponification) at sites of lipid breakdown.

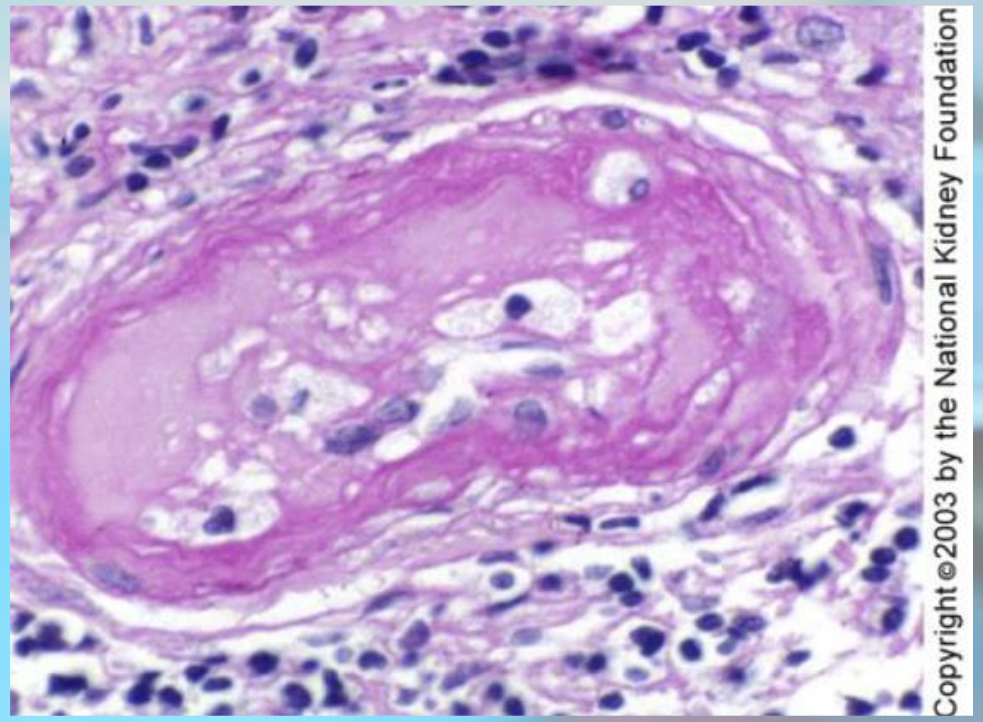


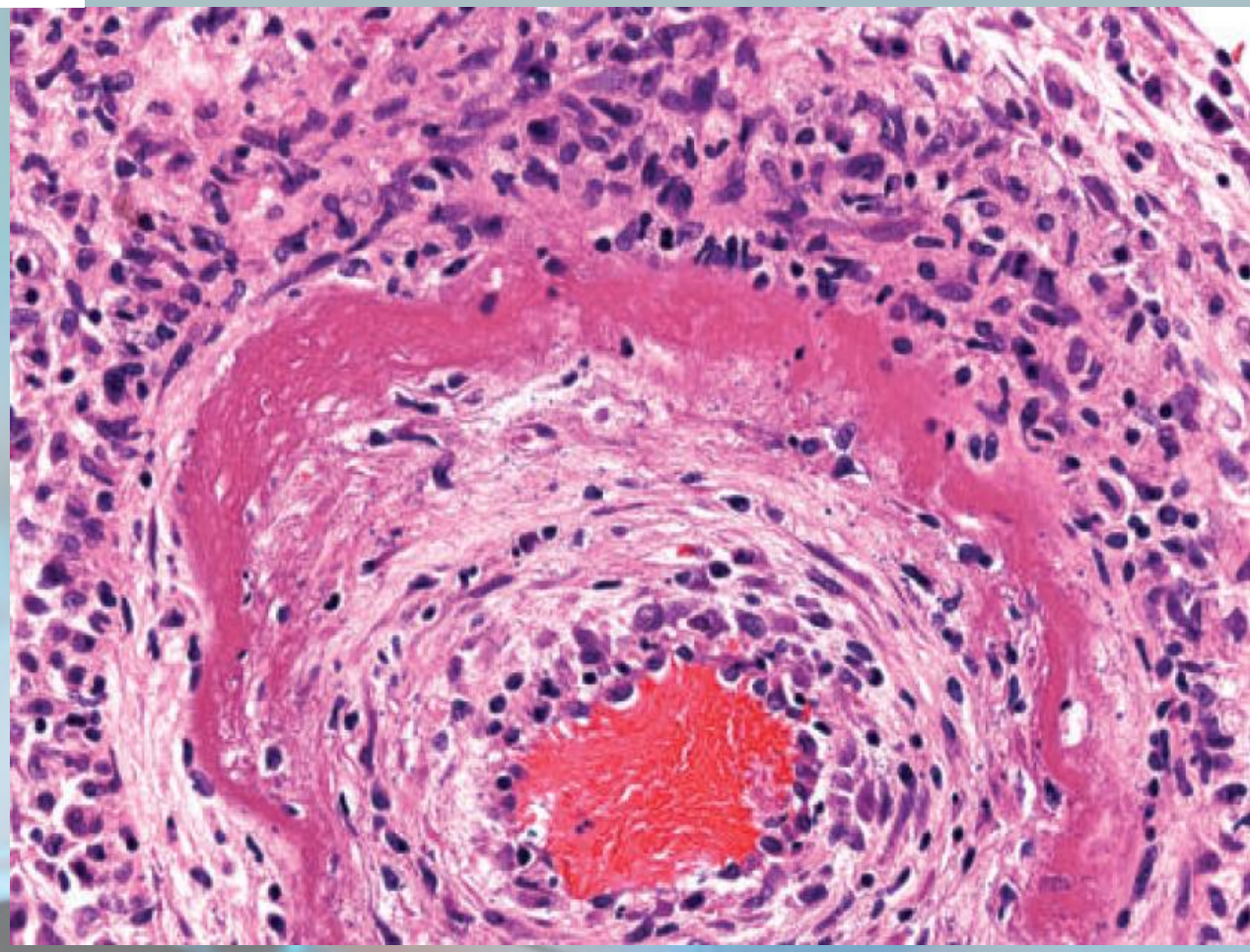
Microscopic: fat necrosis is seen here.
The **necrotic fat cells** have vague cellular outlines, have lost their nuclei, and their cytoplasm has become a pink mass of necrotic material.



Types of Necrosis: 6. Fibrinoid Necrosis

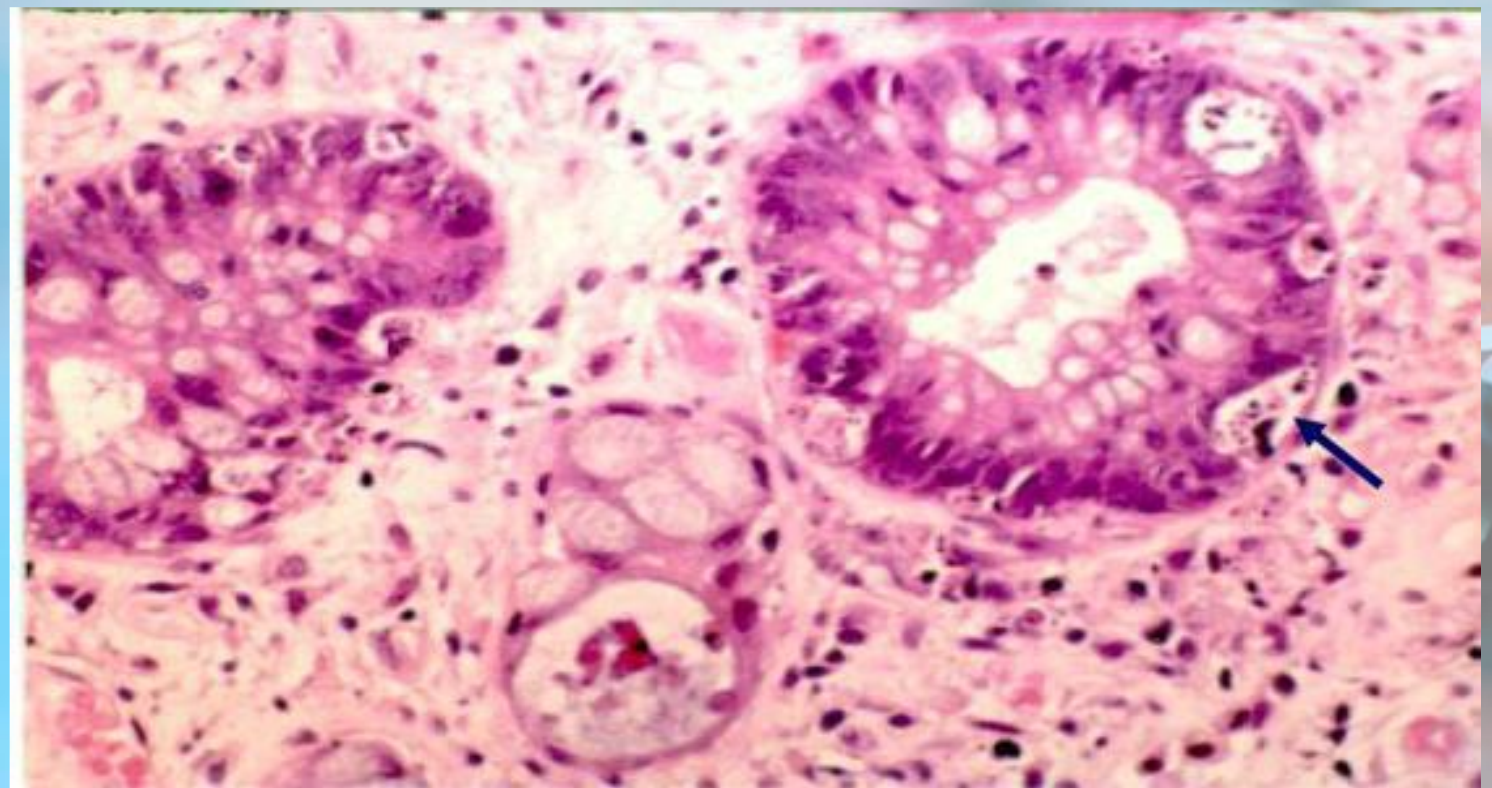
Fibrinoid necrosis of an artery. The wall of the artery shows a circumferential bright pink area of necrosis with protein deposition and inflammation.

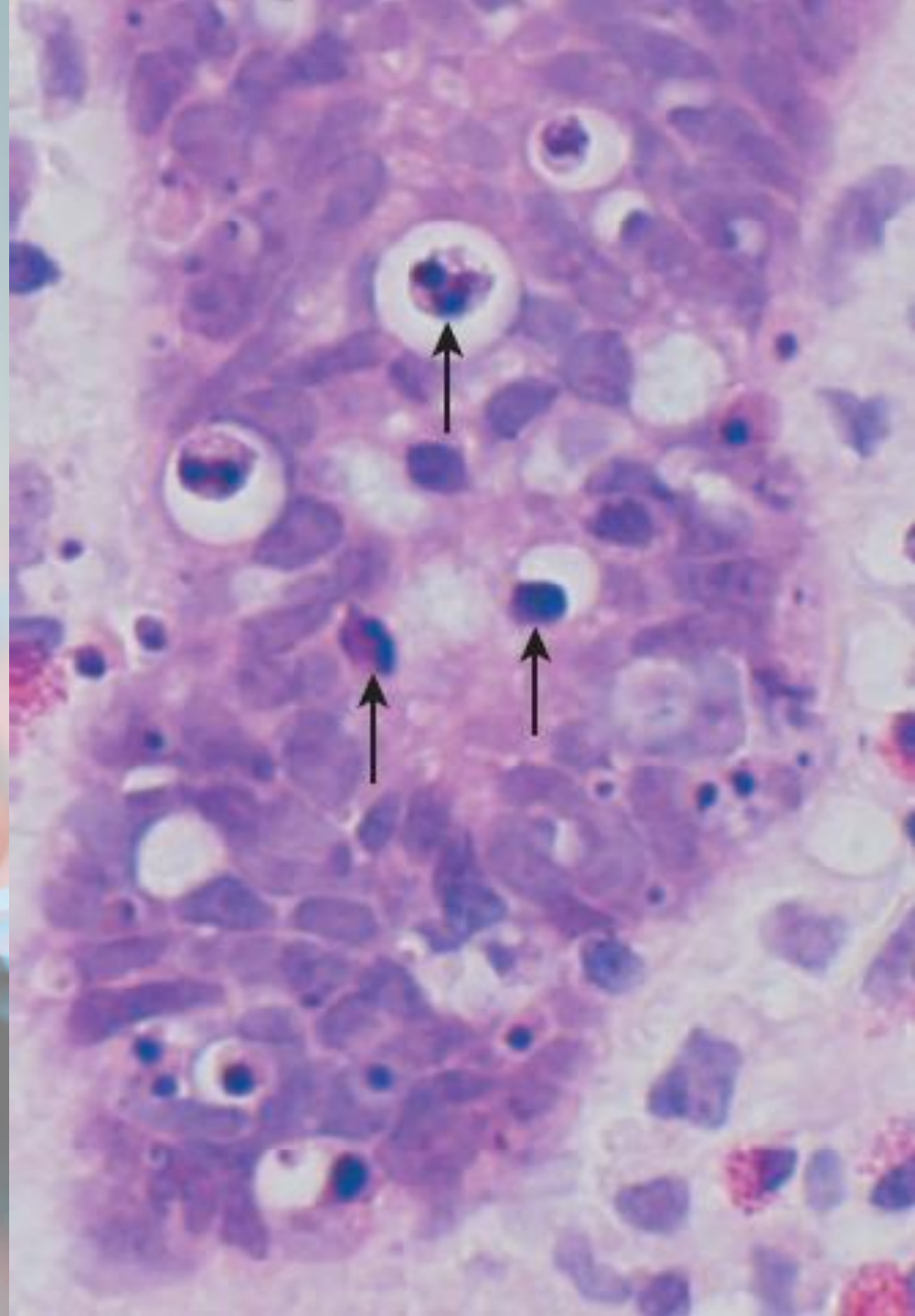




Apoptosis

Morphologic appearance of apoptotic cells. Apoptotic cells (*arrows*) in colonic epithelium are shown. Note the fragmented nuclei with condensed chromatin and the shrunken cell bodies, some with pieces falling off.

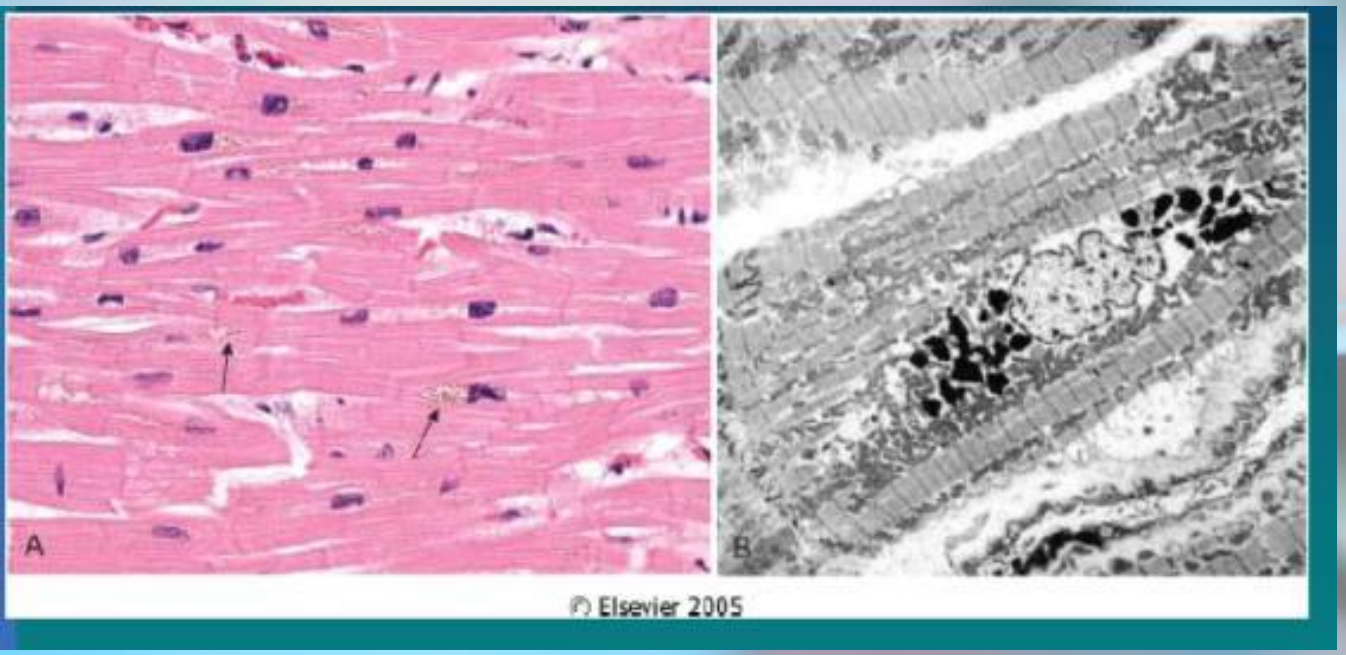


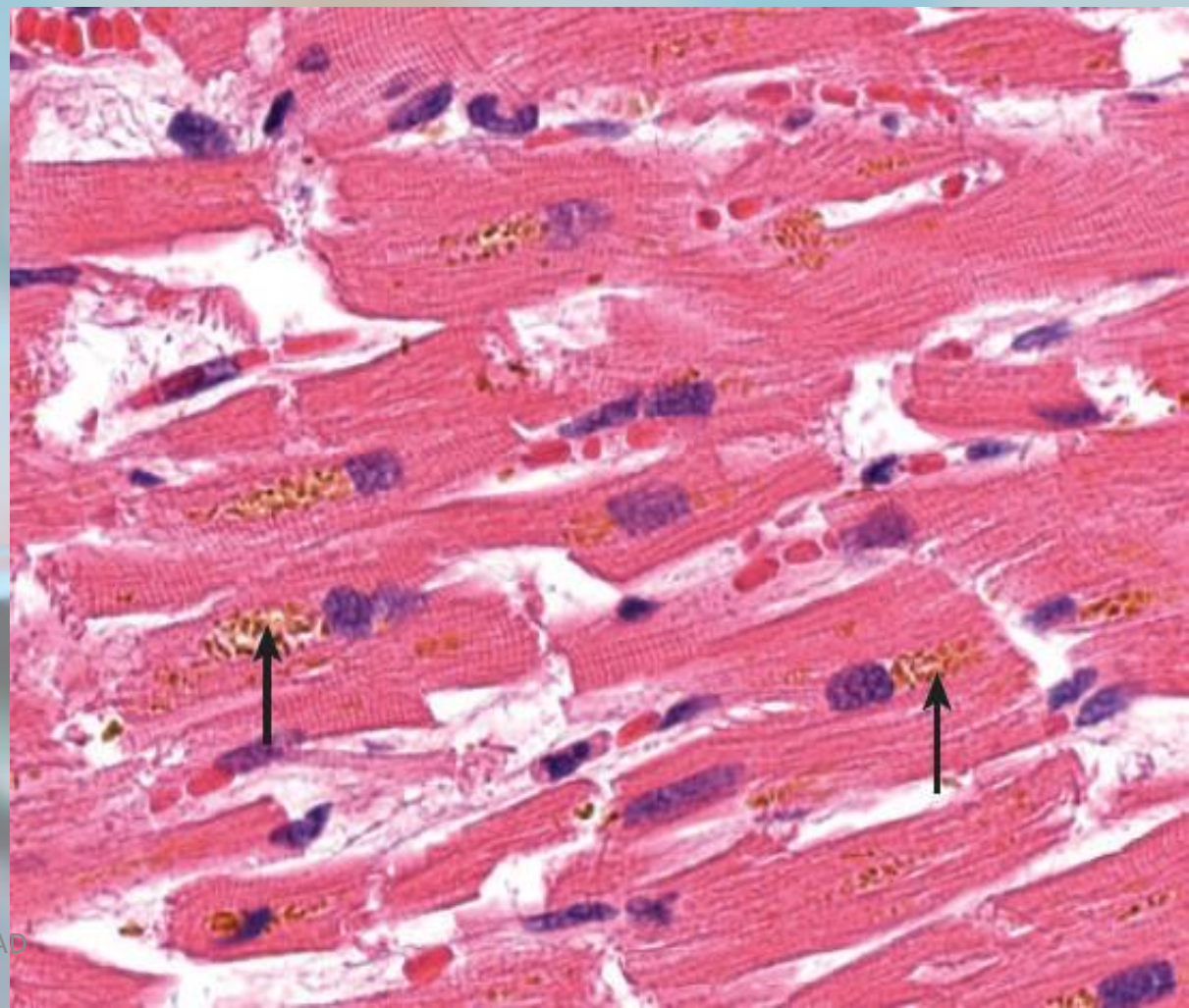


Intracellular Accumulations: 1. Lipofuscin

Lipofuscin: fine yellow-brown pigment granules composed of lipid-containing residues of lysosomal digestion. It is considered to be one of the aging pigments. It is specifically arranged around the nucleus.

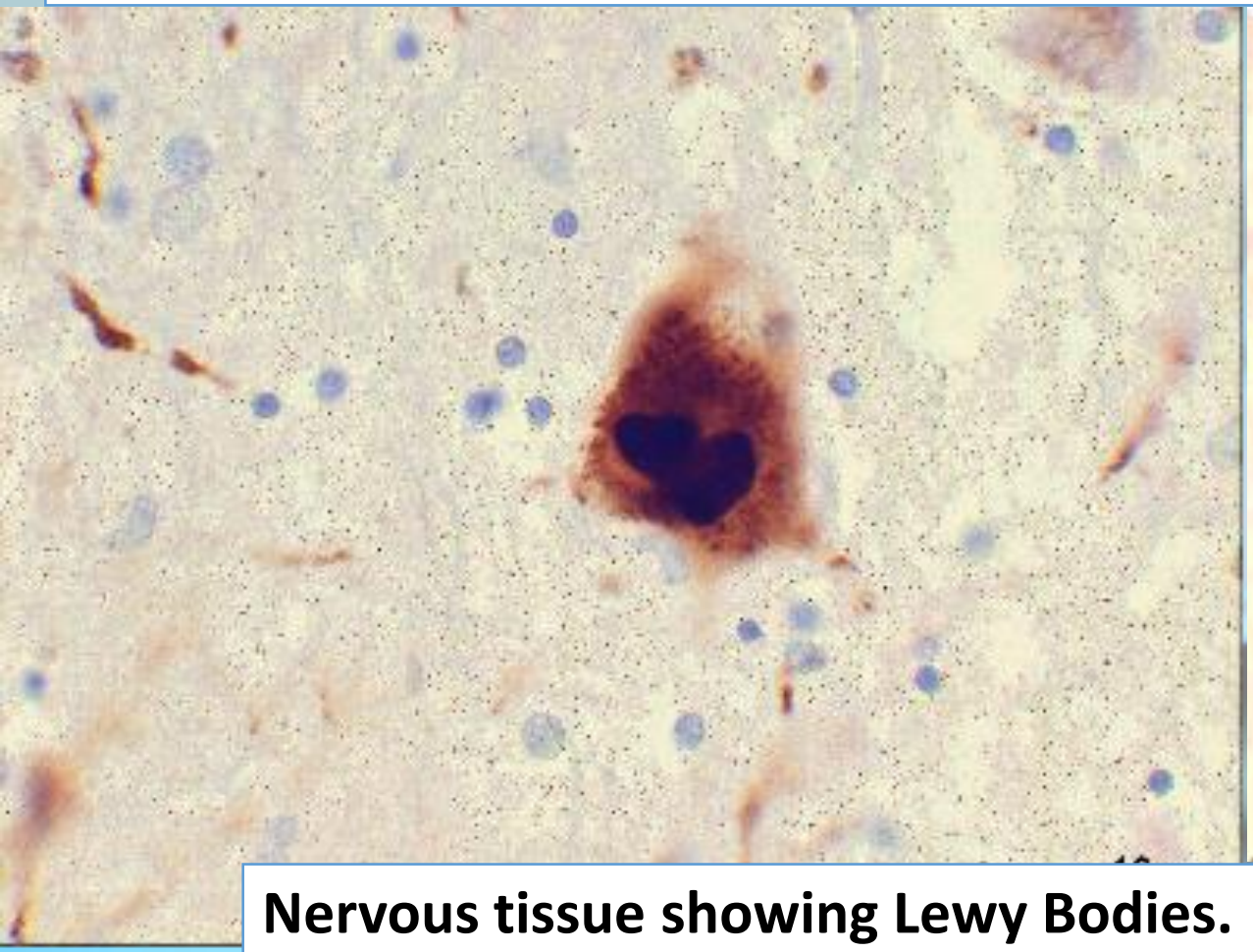
Lipofuscin granules in cardiac myocytes.
Note the yellow-brown pigments near the nucleus of myocytes.

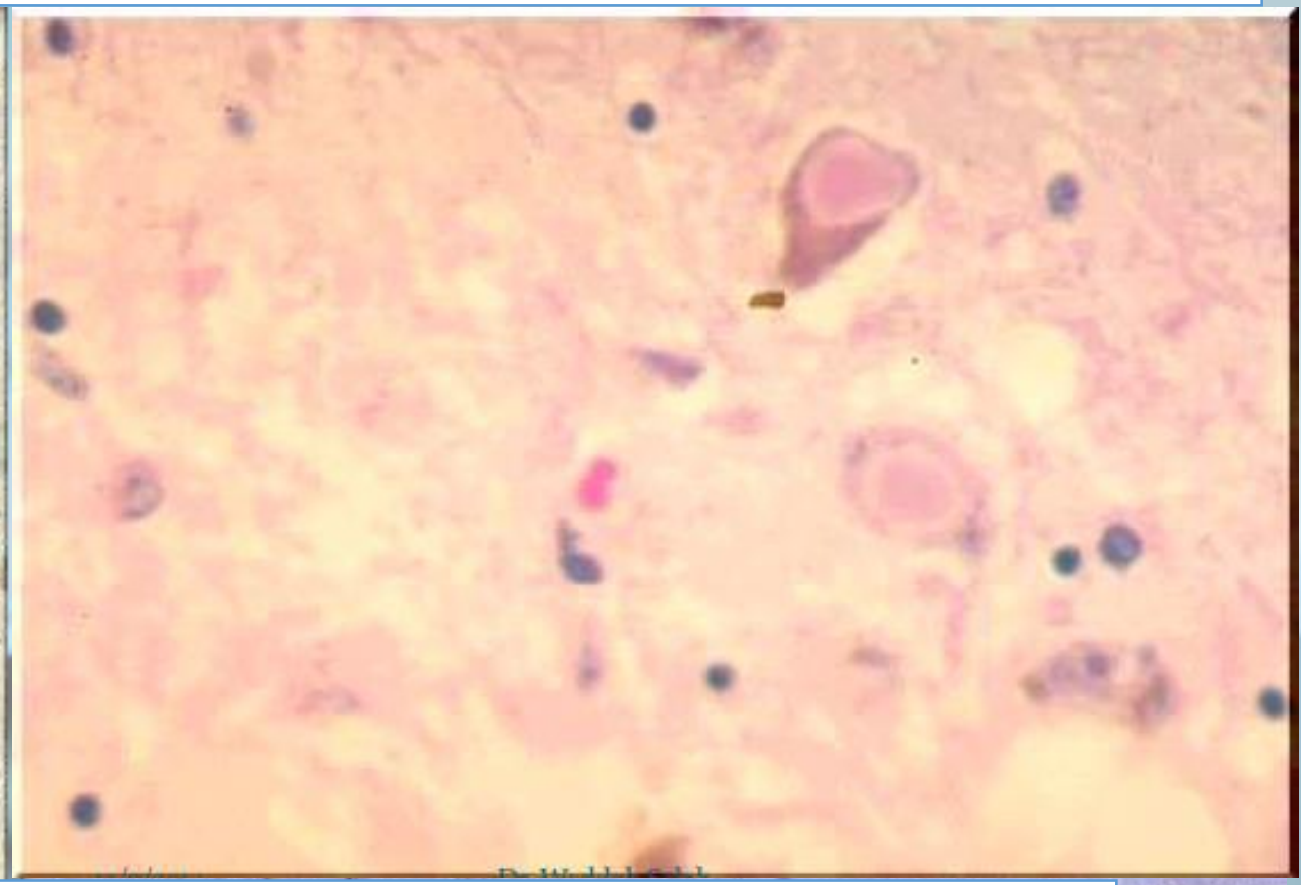




Intracellular Accumulations: 2. Lewy Bodies

Lewy bodies: abnormal aggregations of protein inside nerve cells in some diseases.
A classical Lewy body is an eosinophilic cytoplasmic inclusion consisting of a dense core surrounded by a halo of radiating fibrils.

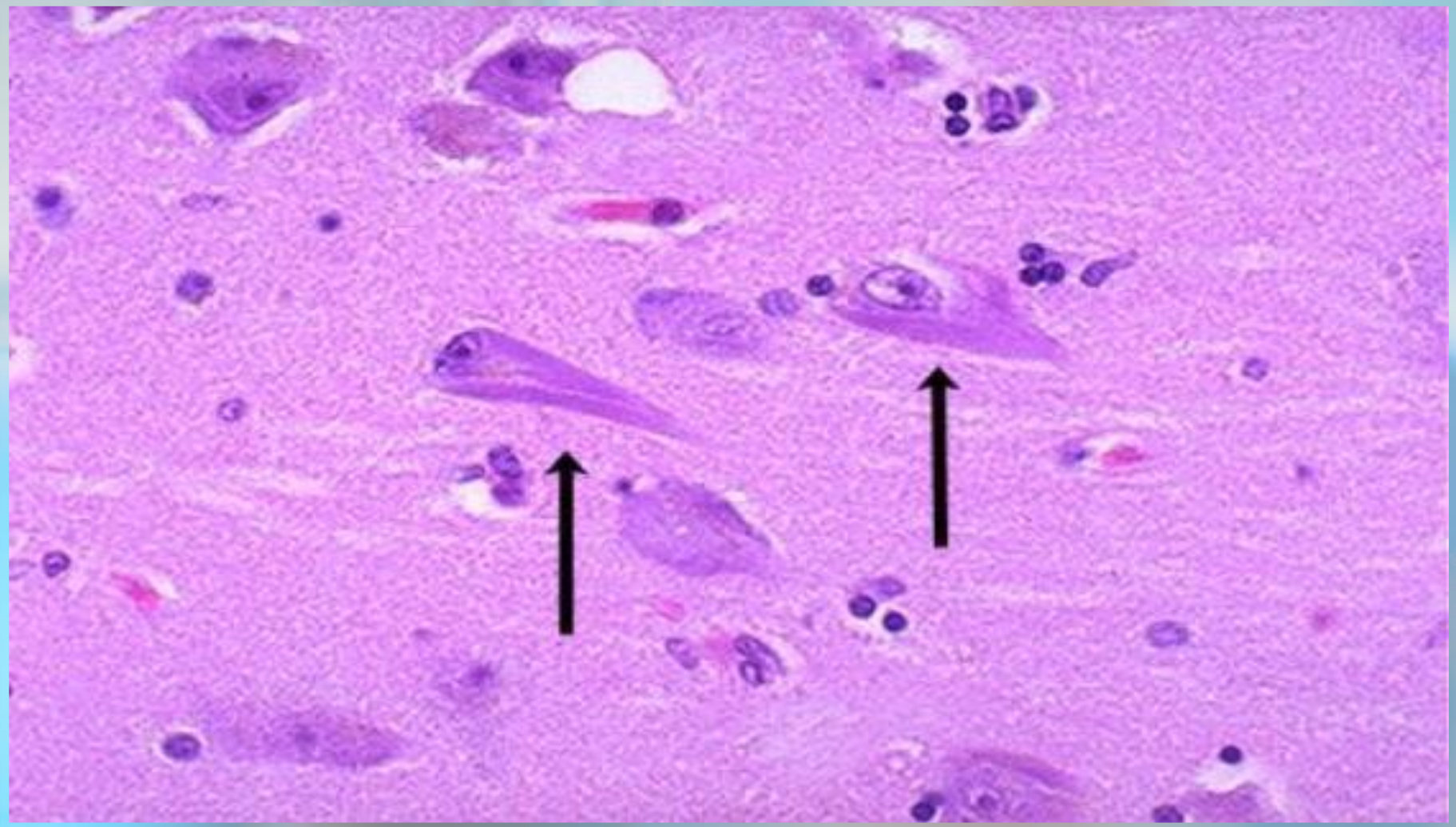




Nervous tissue showing Lewy Bodies. Note the cytoplasmic inclusions consisting of a dense core surrounded by radiating fibrils.

Intracellular Accumulations: 3. Neurofibrillary Tangles

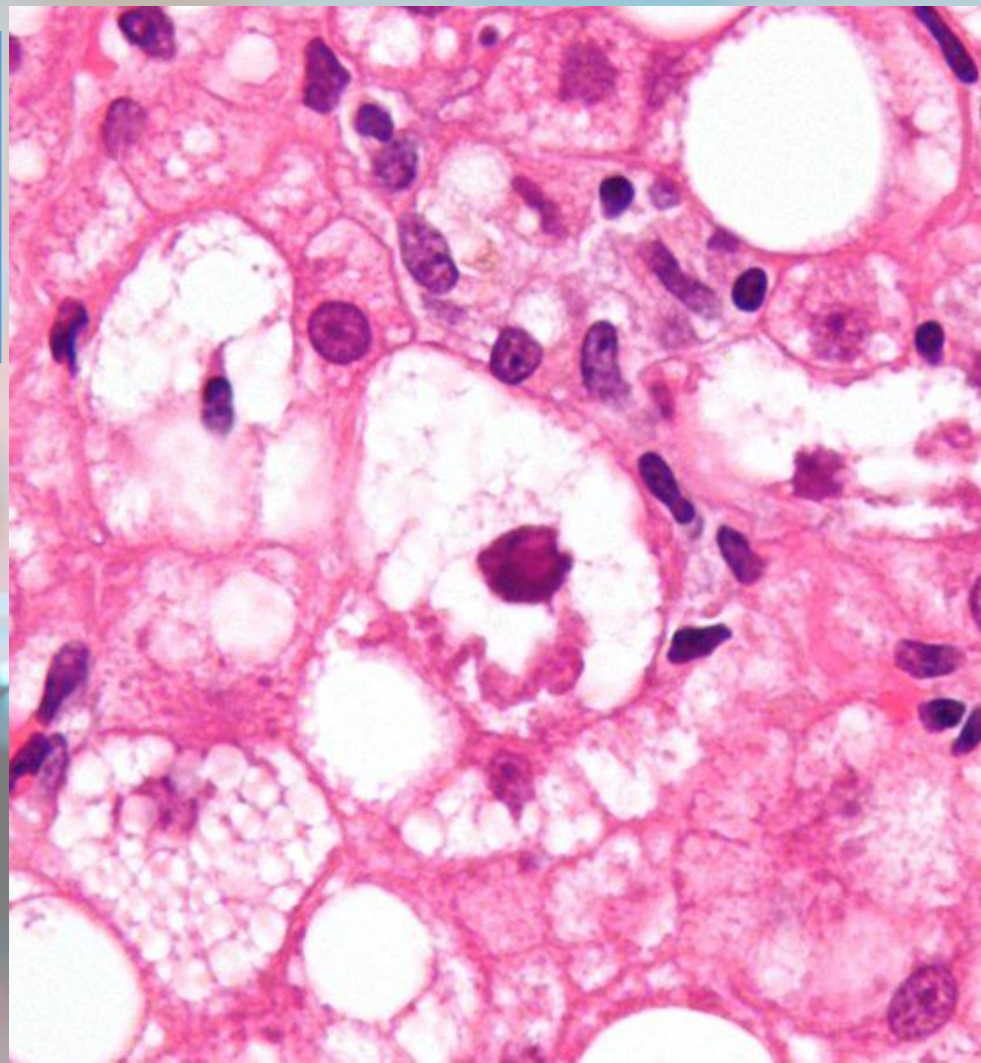
Neurofibrillary tangles (**NFTs**): are aggregates of hyperphosphorylated **tau protein** that are known as a primary marker of **Alzheimer's disease**.
The cytoskeletal filaments are grouped together in the elongated pink tangles.

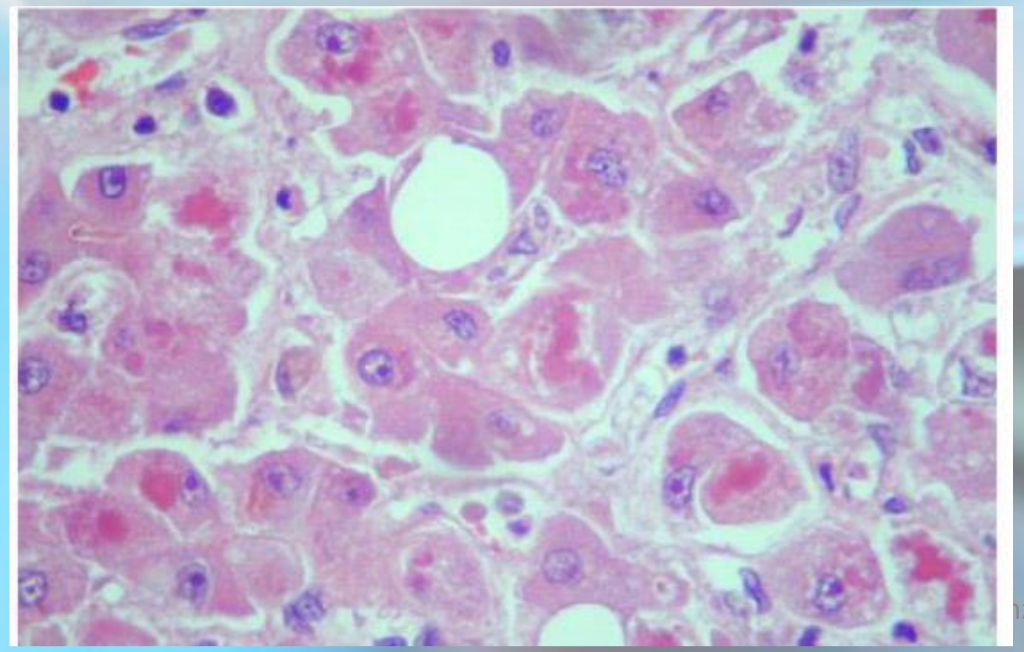


Intracellular Accumulations: 4. Mallory Bodies

Mallory bodies: are eosinophilic cytoplasmic inclusions that are aggregates of denatured keratin filaments. They have a *twisted rope-like* appearance. They often have neutrophils around them. They frequently are seen in hepatocytes undergoing ballooning degeneration.

High power micrograph of a Liver biopsy Stained by H&E. Note **Mallory body;** eosinophilic cytoplasmic inclusion appears as a twisted rope in a Hepatocyte that is surrounded by Neutrophils.





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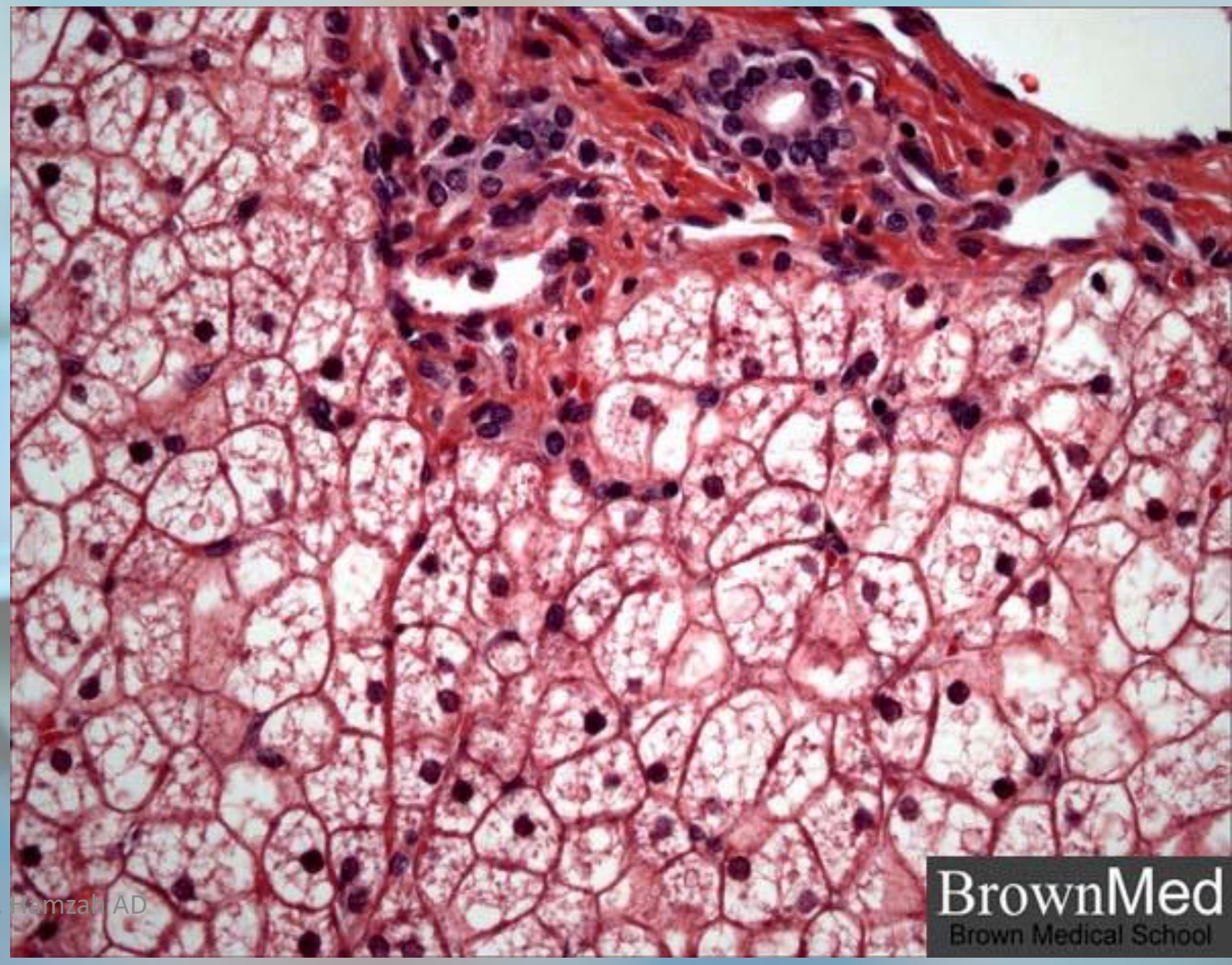
Intracellular Accumulations: 5. Glycogen Storage Disease

Glycogen accumulation in Hepatocytes. Can be demonstrated microscopically by:
1. Mosaic pattern: enlarged hepatocytes with pale cytoplasm compressing sinusoids.
2. Fatty change, hyperglycogenated nuclei

This Liver biopsy shows:
1. Mosaic pattern: enlarged hepatocytes with pale cytoplasm compressing sinusoids.
2. Fatty change, hyperglycogenated nuclei

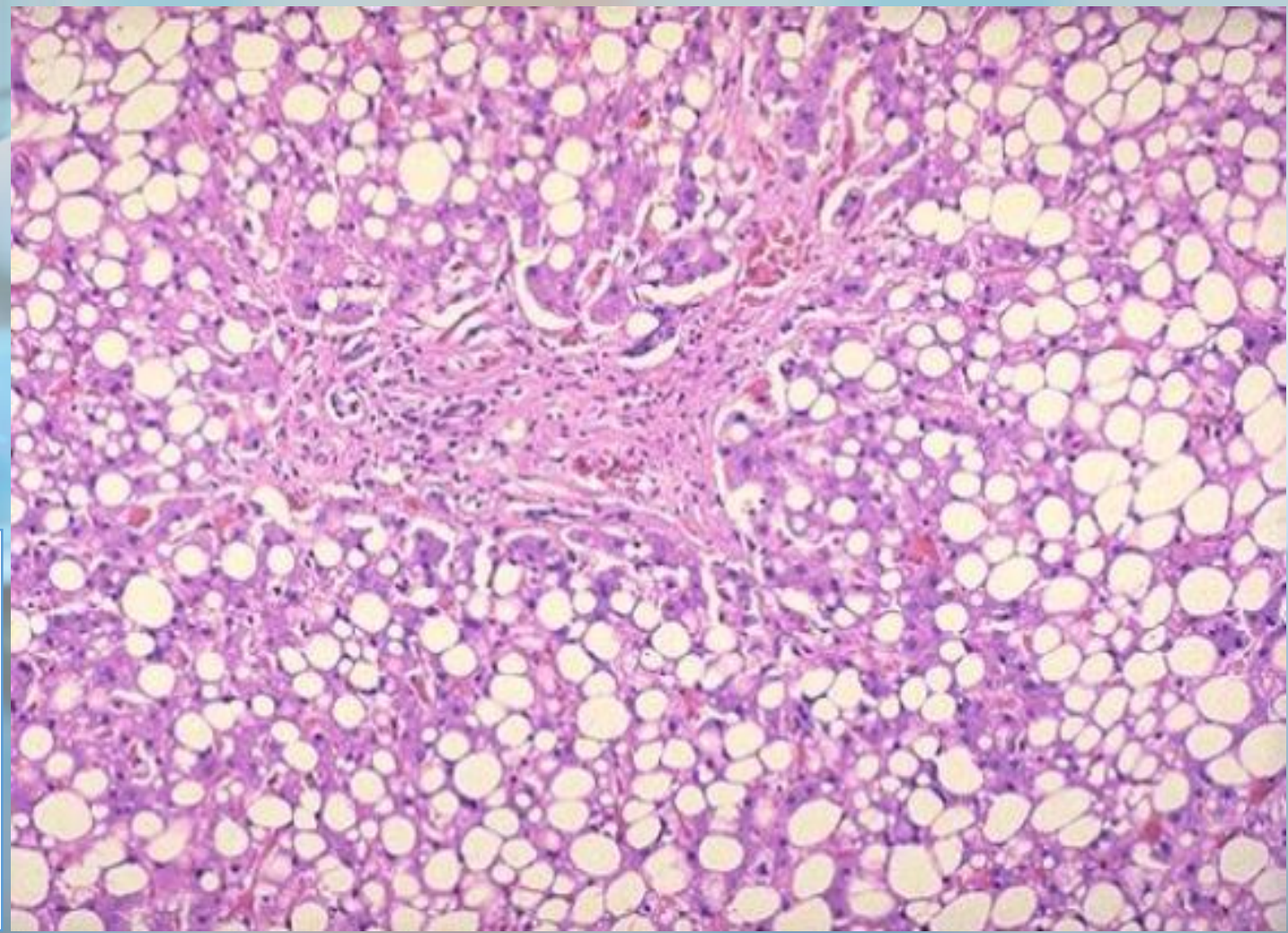


Dr. Hamzah AD

BrownMed
Brown Medical School

Intracellular Accumulations: 6. Fatty Changes (steatosis)

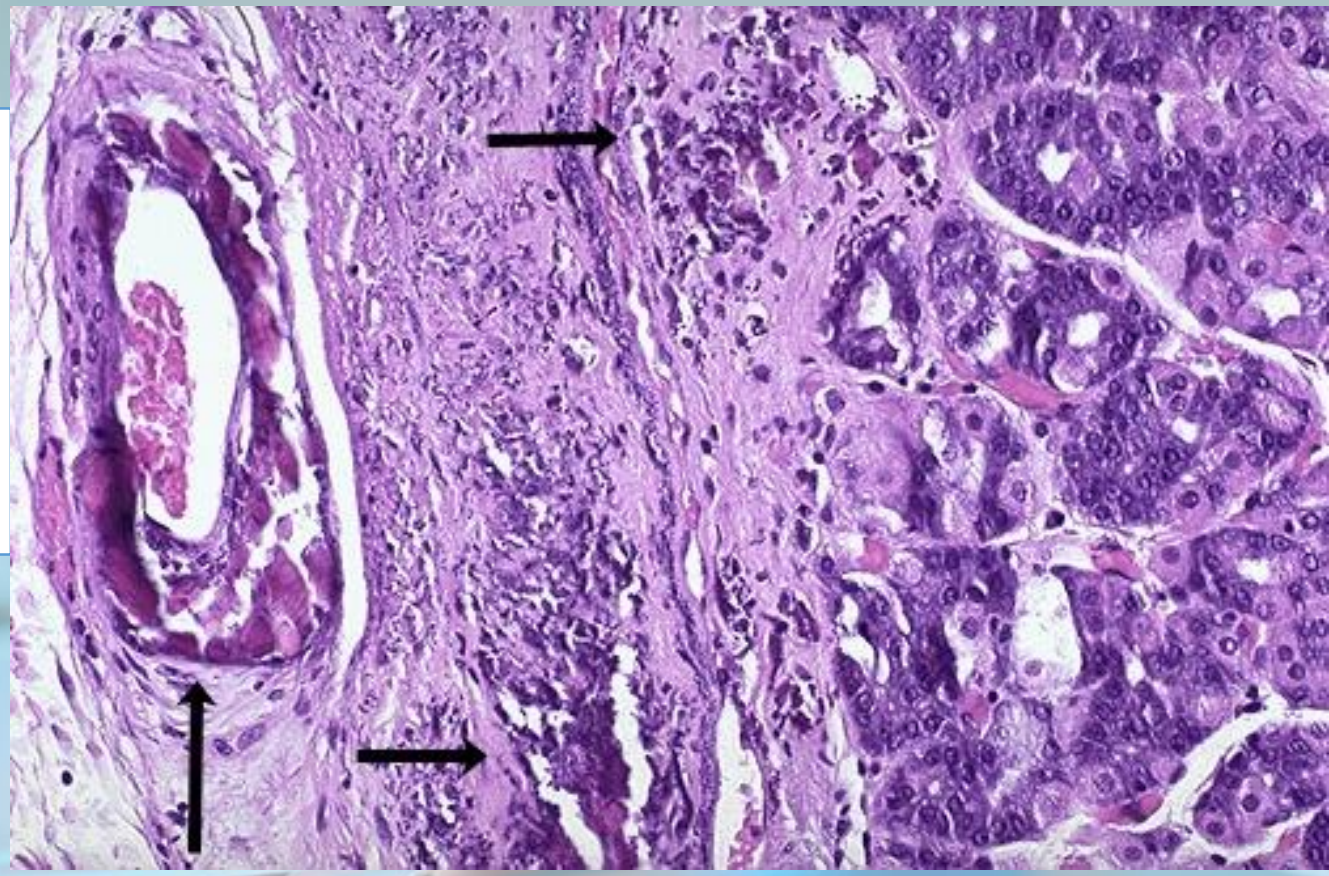
Steatosis (also called **fatty change)** is abnormal retention of fat (lipids) within a cell or organ.
Steatosis reflects an impairment of the normal processes of synthesis and elimination of triglyceride fat.
Excess lipid accumulates in vesicles that displace the cytoplasm.

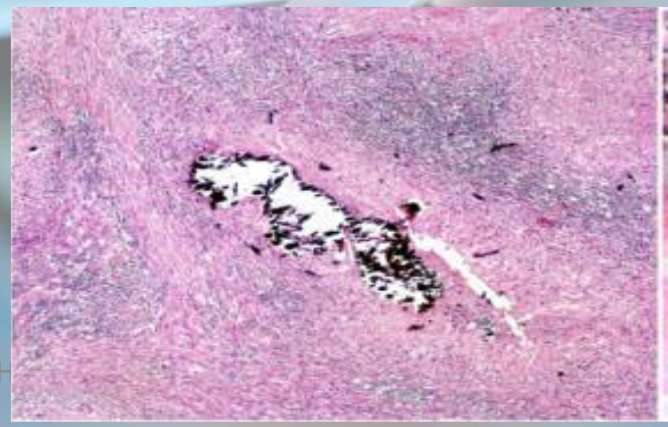


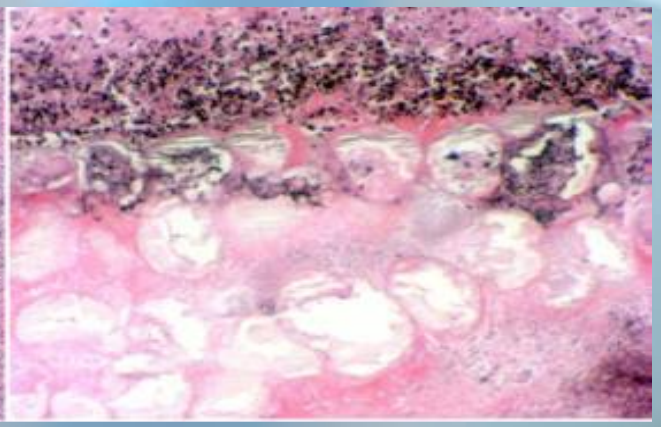
Histological section of a liver showing severe steatosis. The clear cytoplasmic vacuoles would have contained lipid in the living cells, however the histological fixation caused it to be dissolved and hence only empty spaces remain.

Intracellular Accumulations: 7. Calcification

This is calcification in the wall of the stomach. At the far left is an artery with calcification in its wall. There are also irregular bluish-purple deposits of calcium in the submucosa. Calcium is more likely to be deposited in tissues that are damaged.







Thank you..